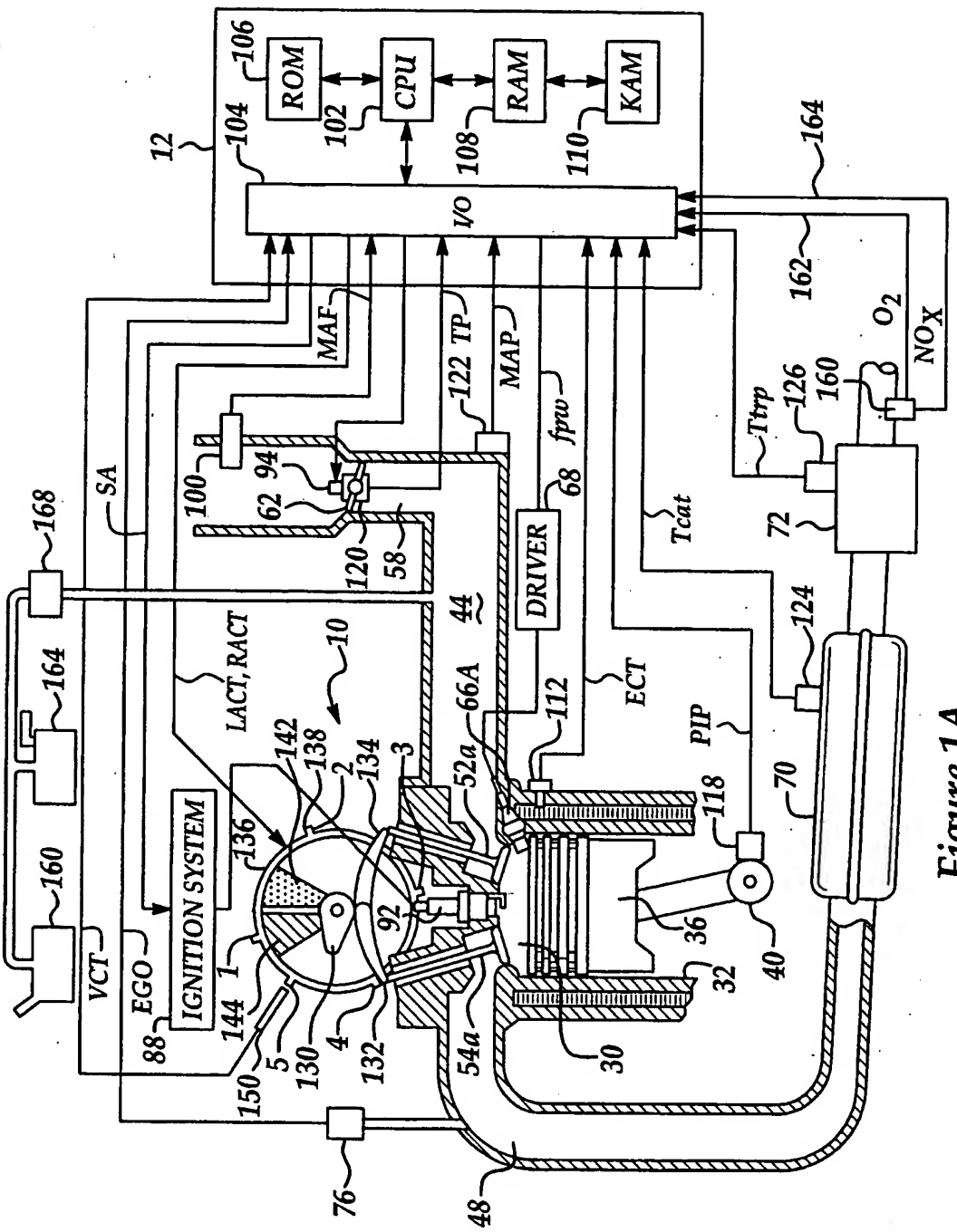

12
104
106
ROM
CPU
RAM
KAM
102
108
110
I/O
164
162
MAF
122 TP
MAP
fpw
68
DRIVER
Tcat
ECT
PIP
Ttrp
126
160
O_2
NO_X
72
124
70
118
112
66A
52a
54a
30
32
36
40
168
SA
100
94
62
120
58
44
10
LACT, RACT
142
138
2
134
3
136
92
IGNITION SYSTEM
1
144
5
130
4
132
150
88
EGO
VCT
160
164
76
48

Figure 1A

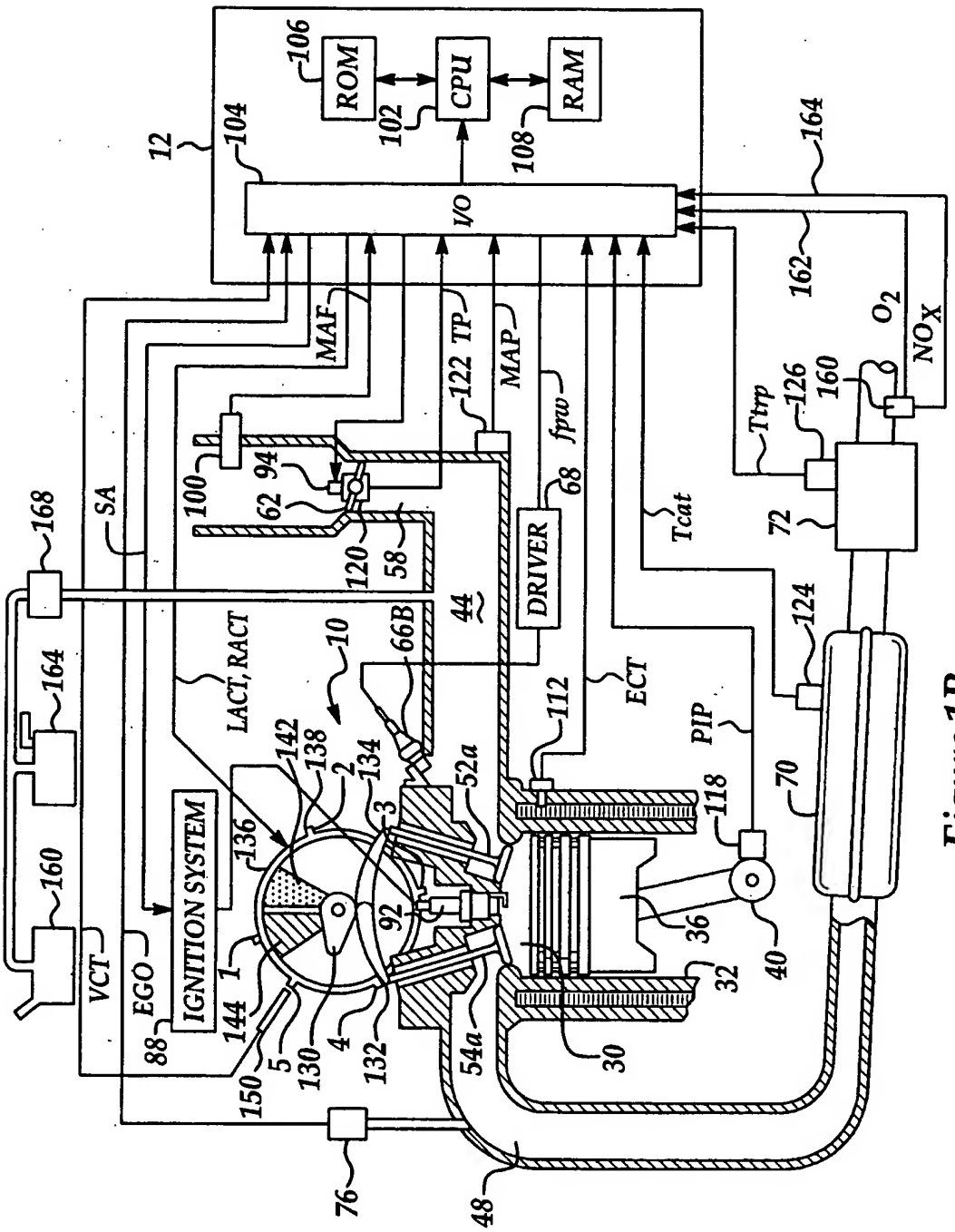

12
104
106
ROM
CPU
RAM
102
108
I/O
164
162
MAF
122 TP
MAP
fpw
68
DRIVER
Tcat
ECT
PIP
112
Ttrp
126
160
O_2
NO_X
72
124
70
118
36
40
32
30
168
SA
100
94
62
120
58
44
66B
10
LACT, RACT
142
138
134
2
3
52a
136
92
1
144
5
130
4
132
54a
150
76
48
160
VCT
EGO
88
IGNITION SYSTEM
164

Figure 1B

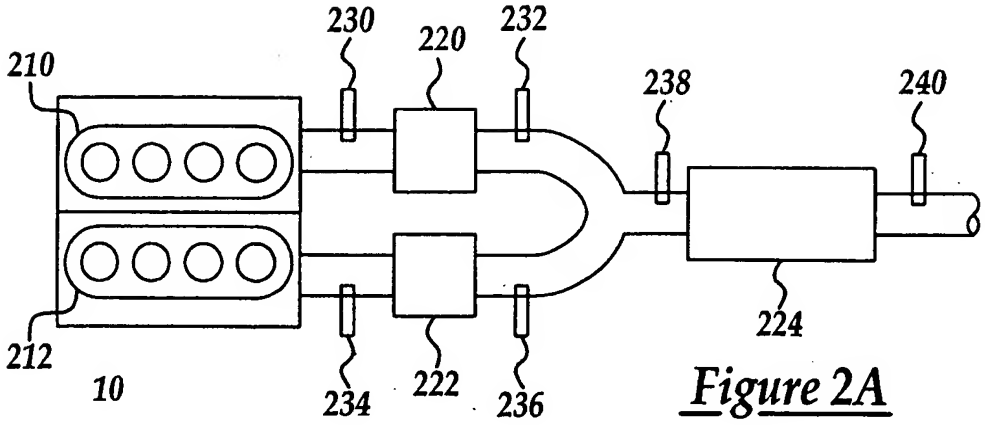


Figure 2A

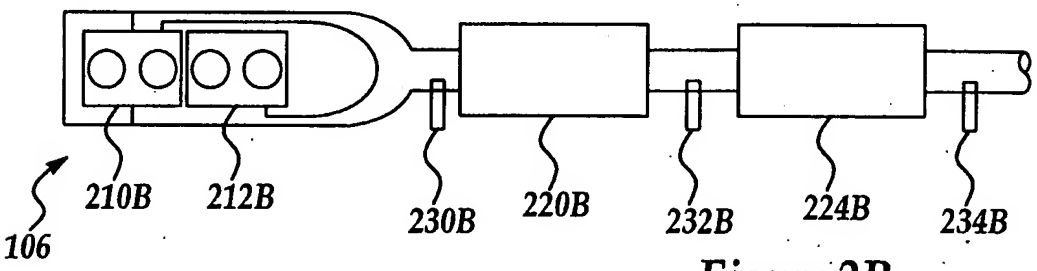


Figure 2B

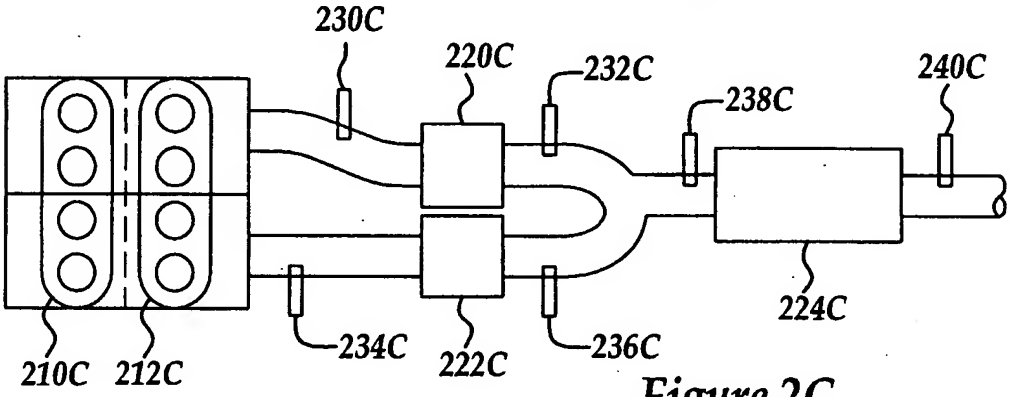


Figure 2C

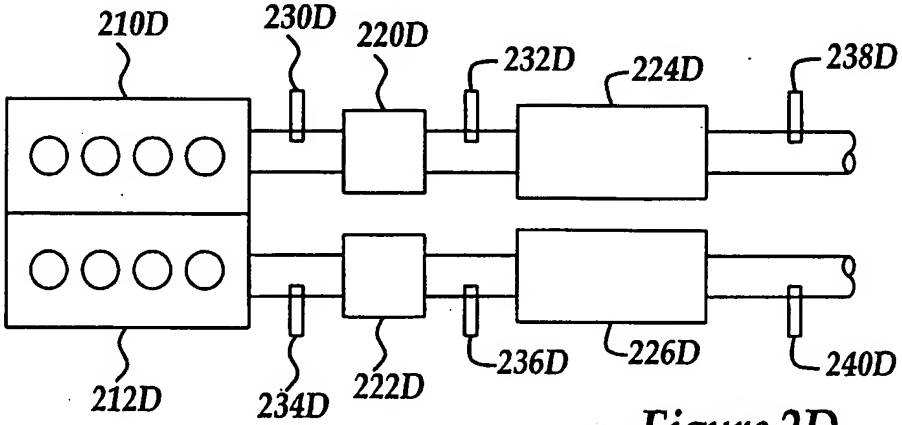
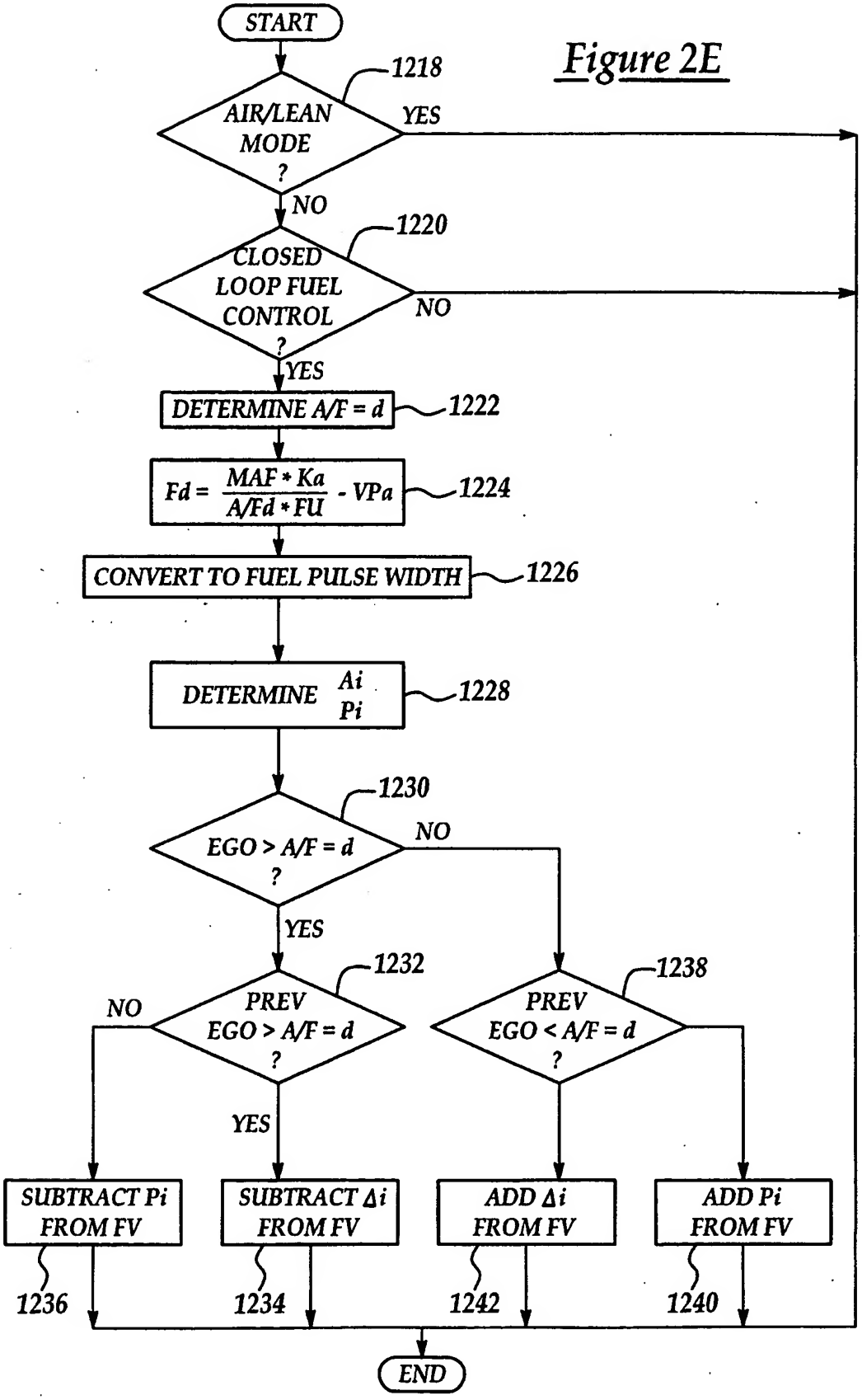


Figure 2D

Figure 2E


START
1218
AIR/LEAN MODE ?
YES
NO
1220
CLOSED LOOP FUEL CONTROL ?
NO
YES
DETERMINE A/F = d
1222
Fd = MAF * Ka / A/Fd * FU - VPa
1224
CONVERT TO FUEL PULSE WIDTH
1226
DETERMINE Ai Pi
1228
1230
EGO > A/F = d ?
NO
YES
1232
PREV EGO > A/F = d ?
NO
YES
1238
PREV EGO < A/F = d ?
SUBTRACT Pi FROM FV
SUBTRACT Δi FROM FV
ADD Δi FROM FV
ADD Pi FROM FV
1236
1234
1242
1240
END

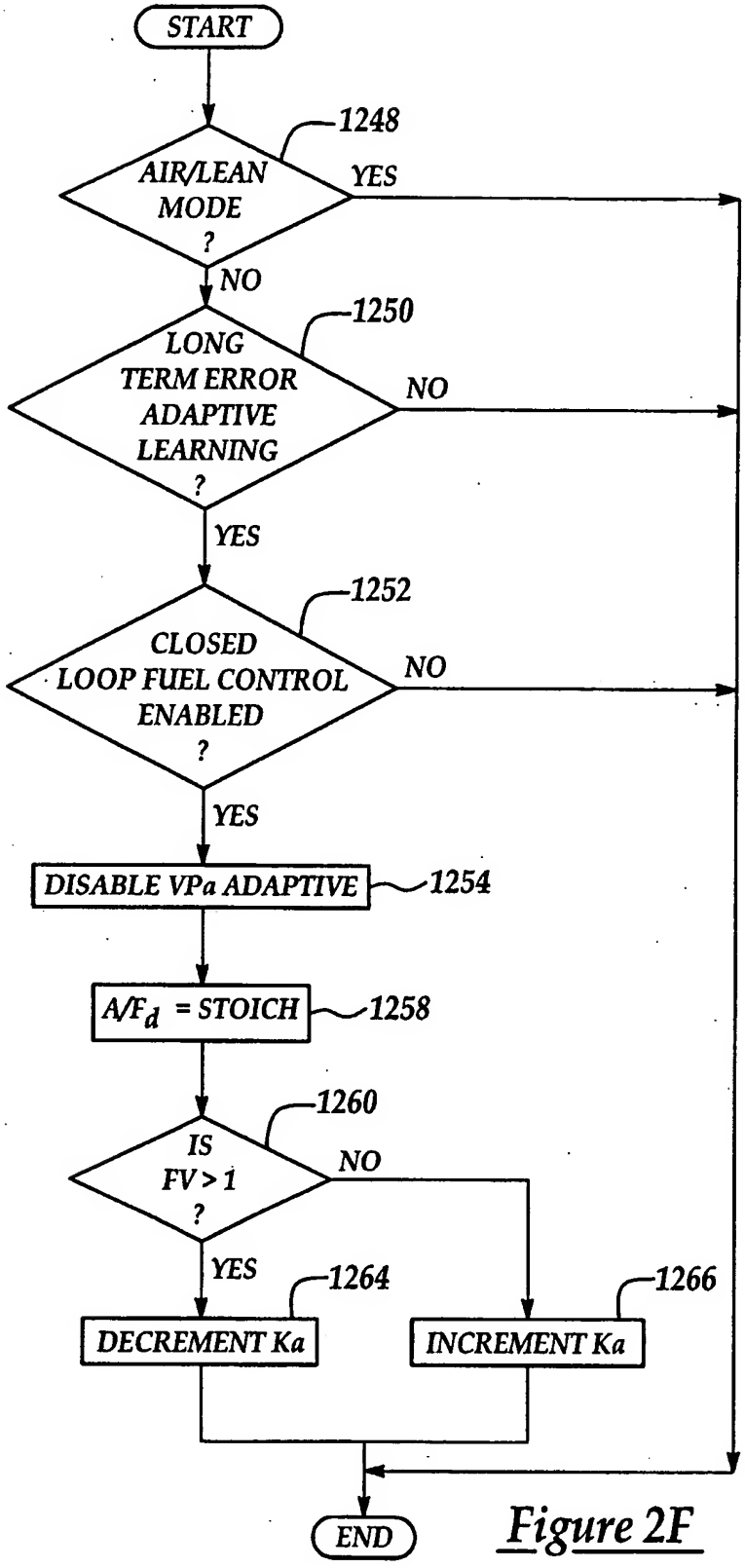

START
1248
AIR/LEAN MODE ?
YES
NO
1250
LONG TERM ERROR ADAPTIVE LEARNING ?
NO
YES
1252
CLOSED LOOP FUEL CONTROL ENABLED ?
NO
YES
DISABLE VPa ADAPTIVE
1254
A/F_d = STOICH
1258
1260
IS FV > 1 ?
NO
YES
1264
1266
DECREMENT Ka
INCREMENT Ka
END

Figure 2F

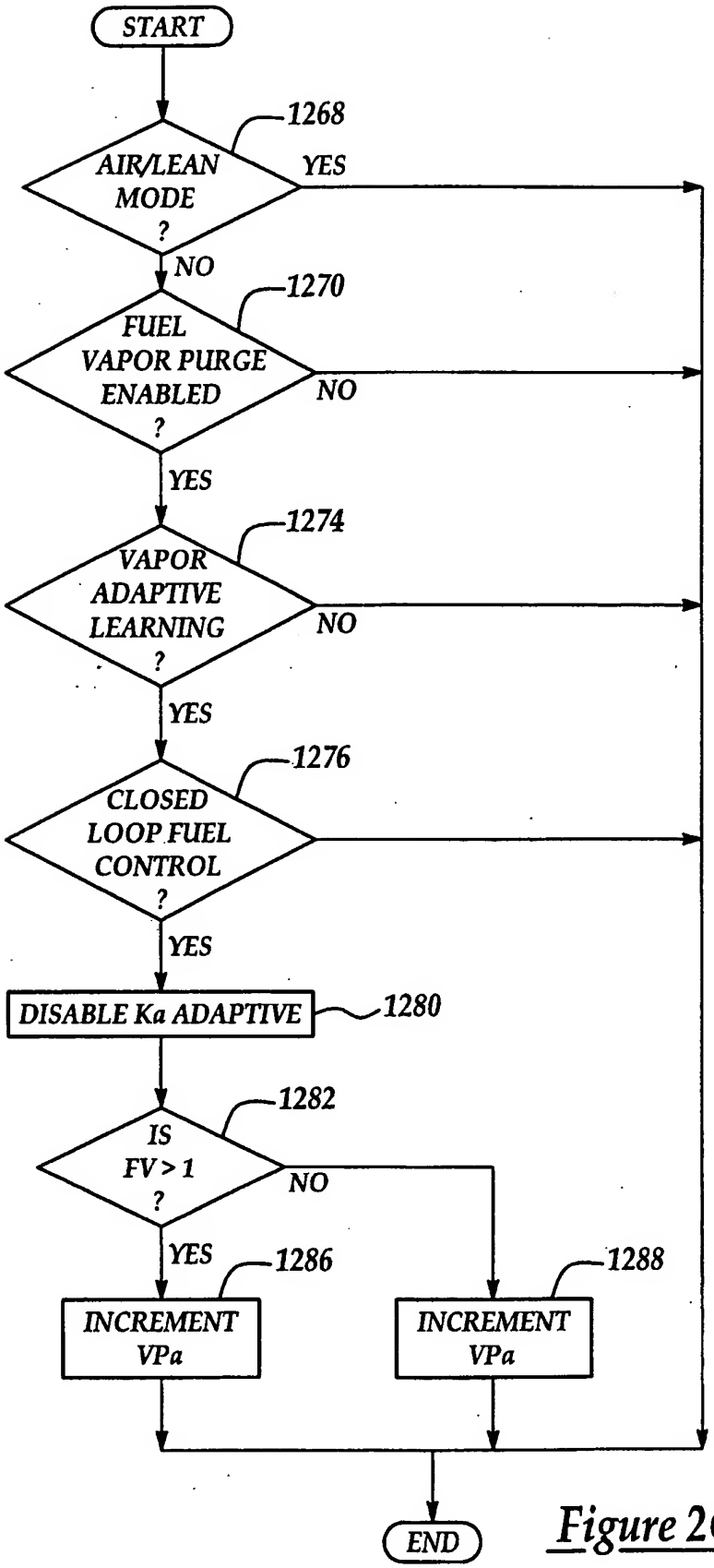

START
1268
AIR/LEAN MODE ?
YES
NO
1270
FUEL VAPOR PURGE ENABLED ?
NO
YES
1274
VAPOR ADAPTIVE LEARNING ?
NO
YES
1276
CLOSED LOOP FUEL CONTROL ?
YES
DISABLE Ka ADAPTIVE
1280
1282
IS FV > 1 ?
NO
YES
1286
INCREMENT VPa
1288
INCREMENT VPa
END

Figure 2G

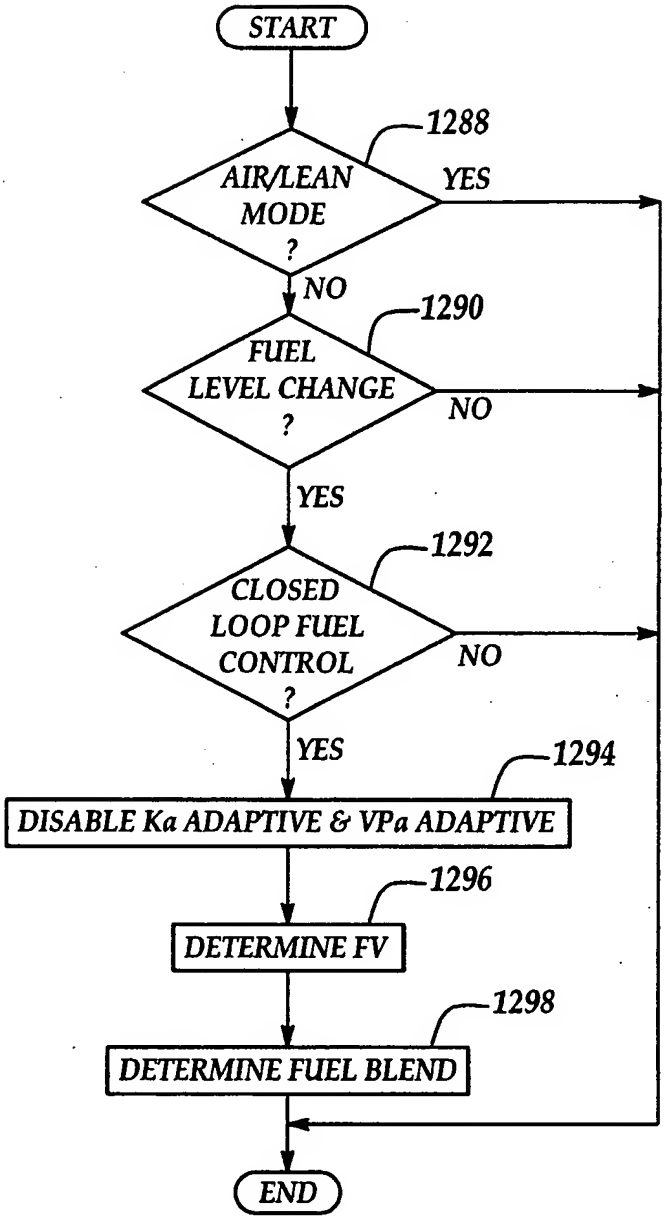

START
1288
AIR/LEAN MODE ?
YES
NO
1290
FUEL LEVEL CHANGE ?
NO
YES
1292
CLOSED LOOP FUEL CONTROL ?
NO
YES
1294
DISABLE Ka ADAPTIVE & VPa ADAPTIVE
1296
DETERMINE FV
1298
DETERMINE FUEL BLEND
END

Figure 2H

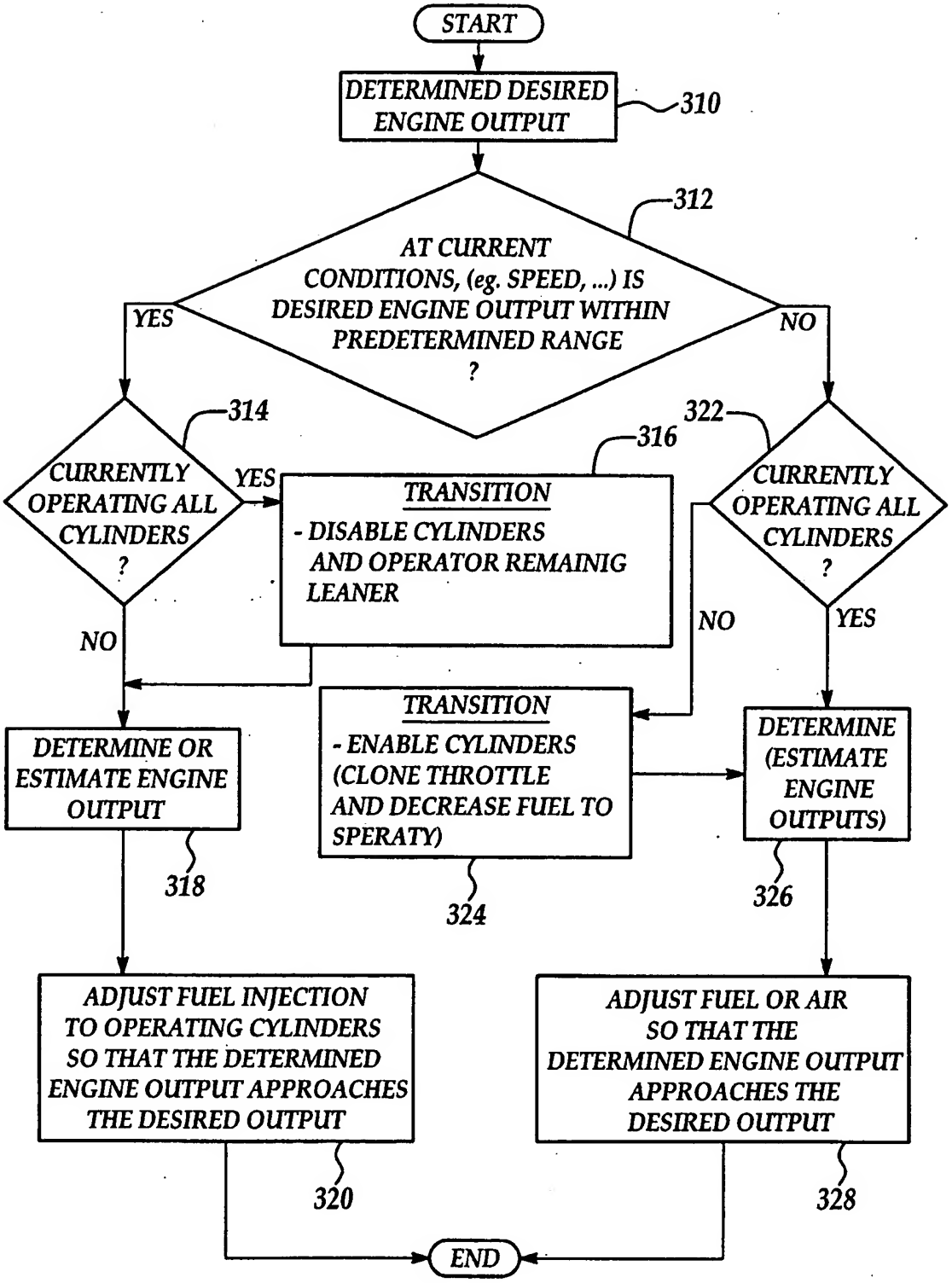

START
DETERMINED DESIRED ENGINE OUTPUT
310
AT CURRENT CONDITIONS, (eg. SPEED, ...) IS DESIRED ENGINE OUTPUT WITHIN PREDETERMINED RANGE ?
312
YES
NO
CURRENTLY OPERATING ALL CYLINDERS ?
314
YES
NO
TRANSITION
- DISABLE CYLINDERS AND OPERATOR REMAINIG LEANER
316
CURRENTLY OPERATING ALL CYLINDERS ?
322
NO
YES
DETERMINE OR ESTIMATE ENGINE OUTPUT
318
TRANSITION
- ENABLE CYLINDERS (CLONE THROTTLE AND DECREASE FUEL TO SPERATY)
324
DETERMINE (ESTIMATE ENGINE OUTPUTS)
326
ADJUST FUEL INJECTION TO OPERATING CYLINDERS SO THAT THE DETERMINED ENGINE OUTPUT APPROACHES THE DESIRED OUTPUT
320
ADJUST FUEL OR AIR SO THAT THE DETERMINED ENGINE OUTPUT APPROACHES THE DESIRED OUTPUT
328
END

Figure 3A

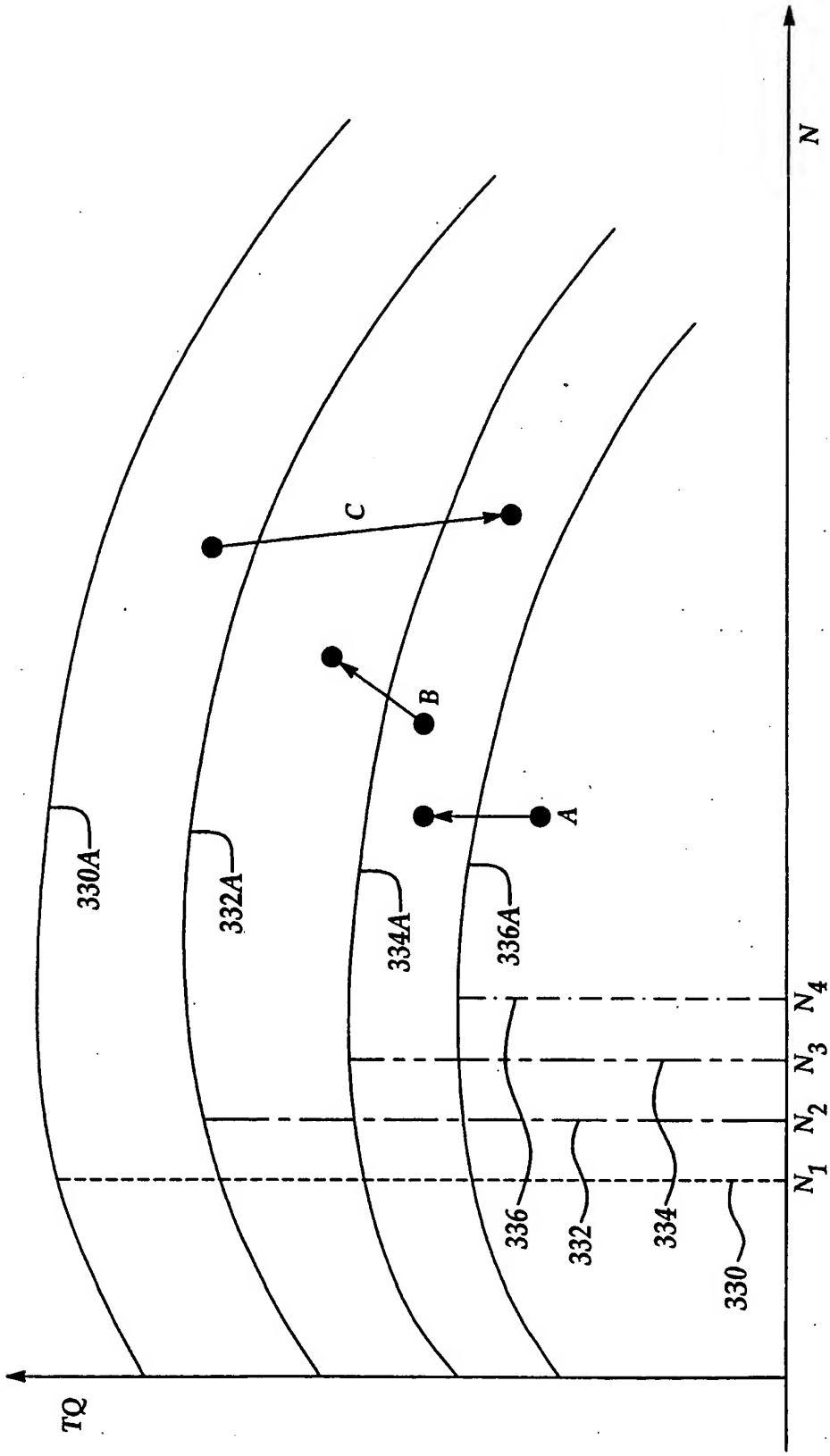


Figure 3B

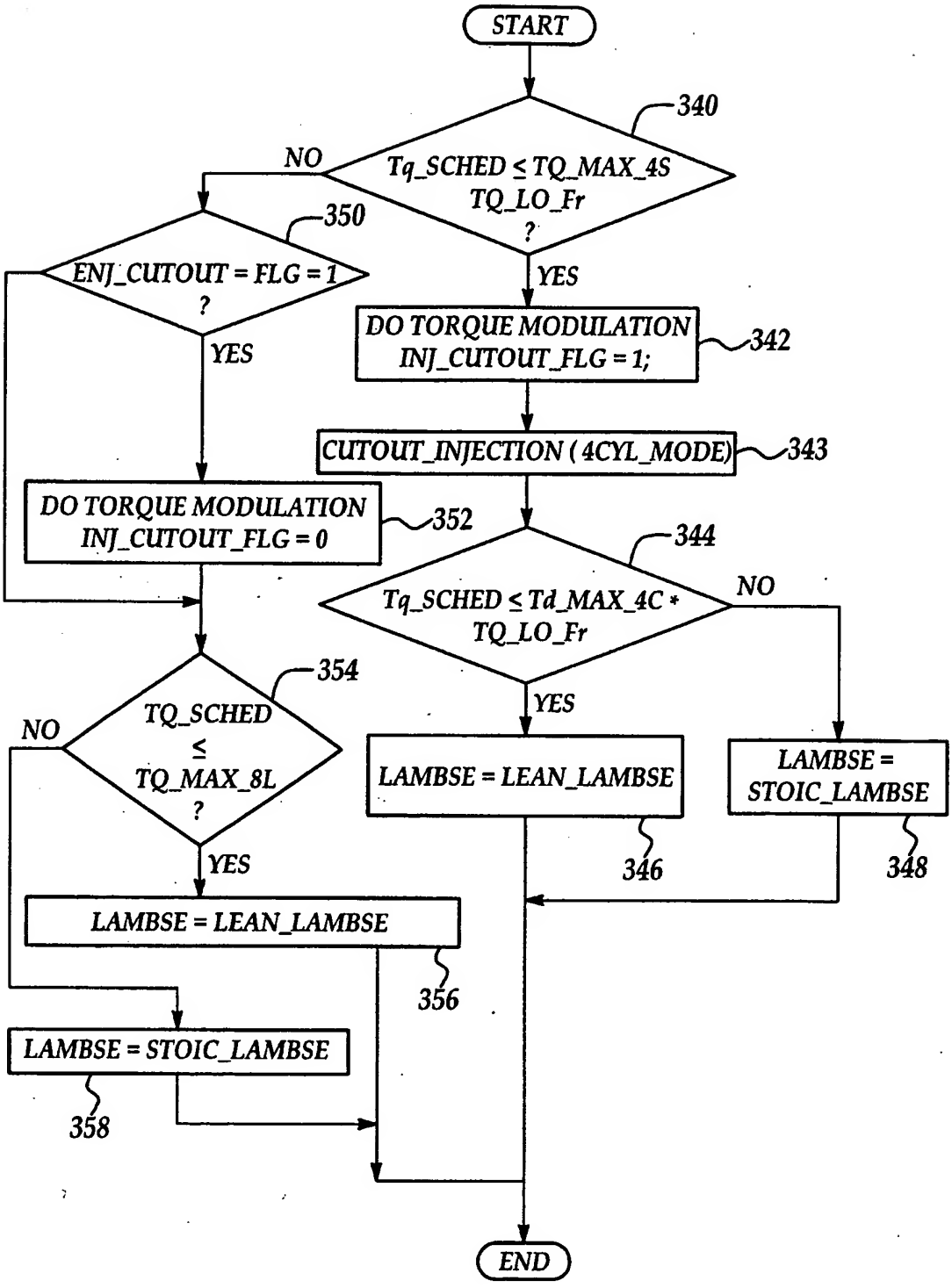

START
340
Tq_SCHED ≤ TQ_MAX_4S TQ_LO_Fr ?
NO
YES
350
ENJ_CUTOUT = FLG = 1 ?
YES
DO TORQUE MODULATION INJ_CUTOUT_FLG = 1;
342
CUTOUT_INJECTION (4CYL_MODE)
343
DO TORQUE MODULATION INJ_CUTOUT_FLG = 0
352
344
Tq_SCHED ≤ Td_MAX_4C * TQ_LO_Fr
NO
YES
354
TQ_SCHED ≤ TQ_MAX_8L ?
NO
YES
LAMBSE = LEAN_LAMBSE
346
LAMBSE = STOIC_LAMBSE
348
LAMBSE = LEAN_LAMBSE
356
LAMBSE = STOIC_LAMBSE
358
END

Figure 3C

Figure 3D(1)A

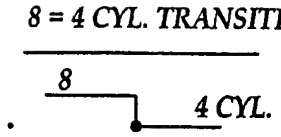


Figure 3D(1)B

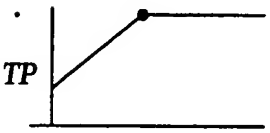


Figure 3D(1)C

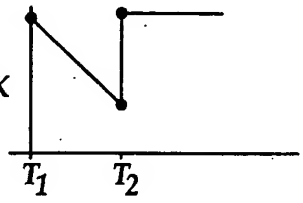
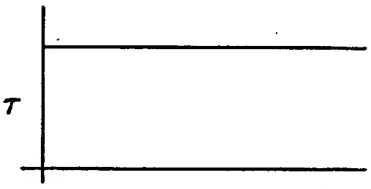


Figure 3D(1)D



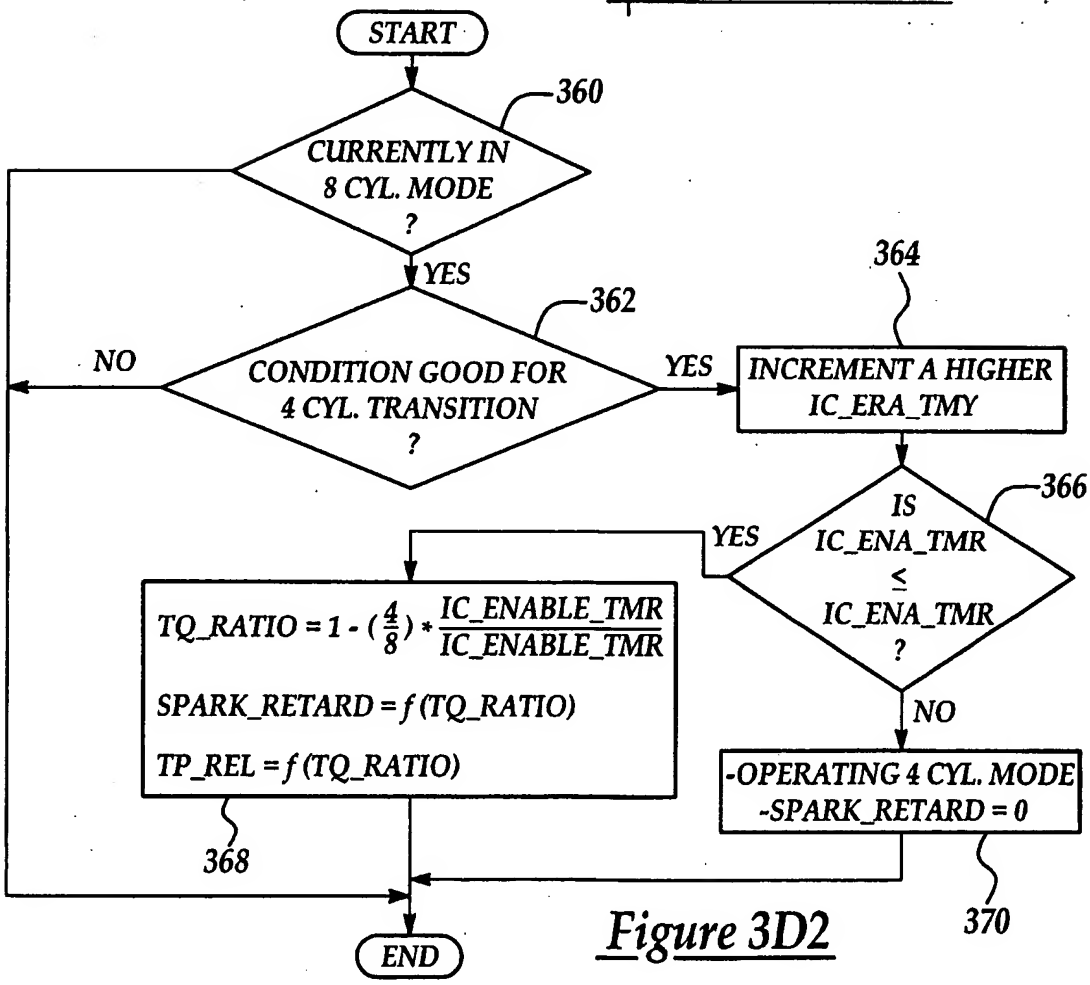


Figure 3D2

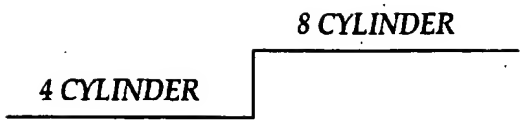


Figure 3D(3)A

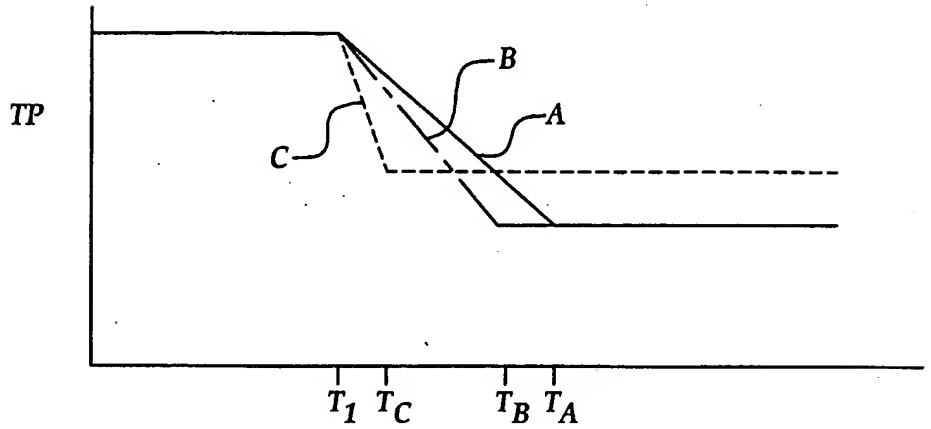


Figure 3D(3)B

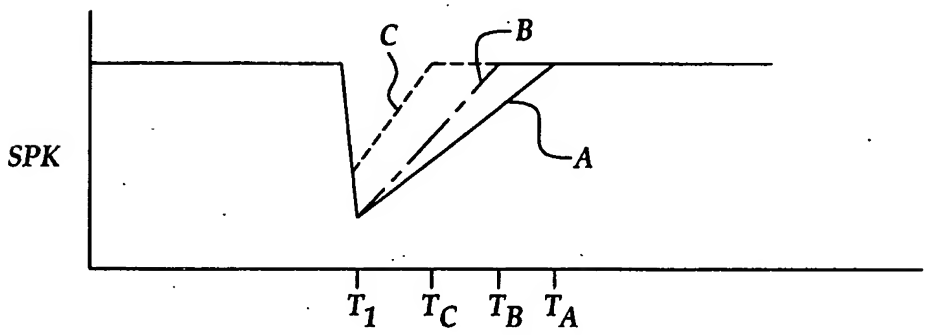


Figure 3D(3)C

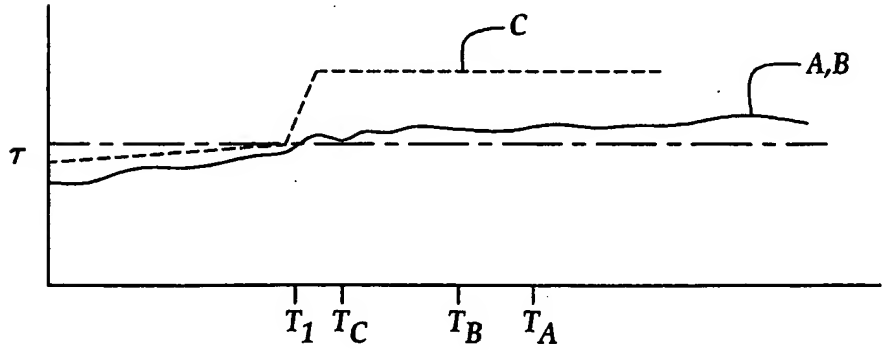


Figure 3D(3)D

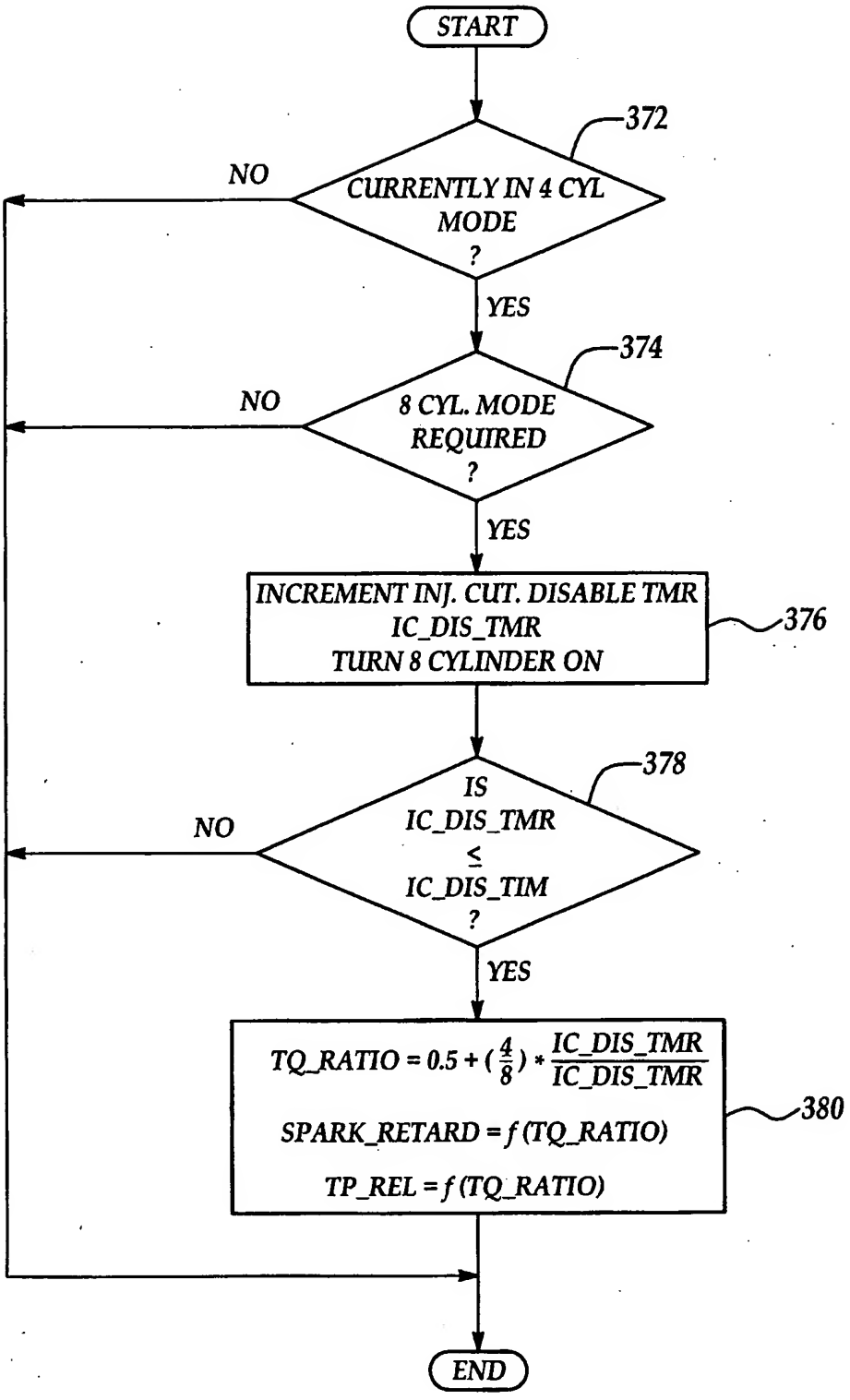

START
372
CURRENTLY IN 4 CYL MODE ?
NO
YES
374
8 CYL. MODE REQUIRED ?
NO
YES
INCREMENT INJ. CUT. DISABLE TMR
IC_DIS_TMR
TURN 8 CYLINDER ON
376
378
IS IC_DIS_TMR ≤ IC_DIS_TIM ?
NO
YES
TQ_RATIO = 0.5 + (4/8) * IC_DIS_TMR / IC_DIS_TMR
SPARK_RETARD = f (TQ_RATIO)
TP_REL = f (TQ_RATIO)
380
END

Figure 3E

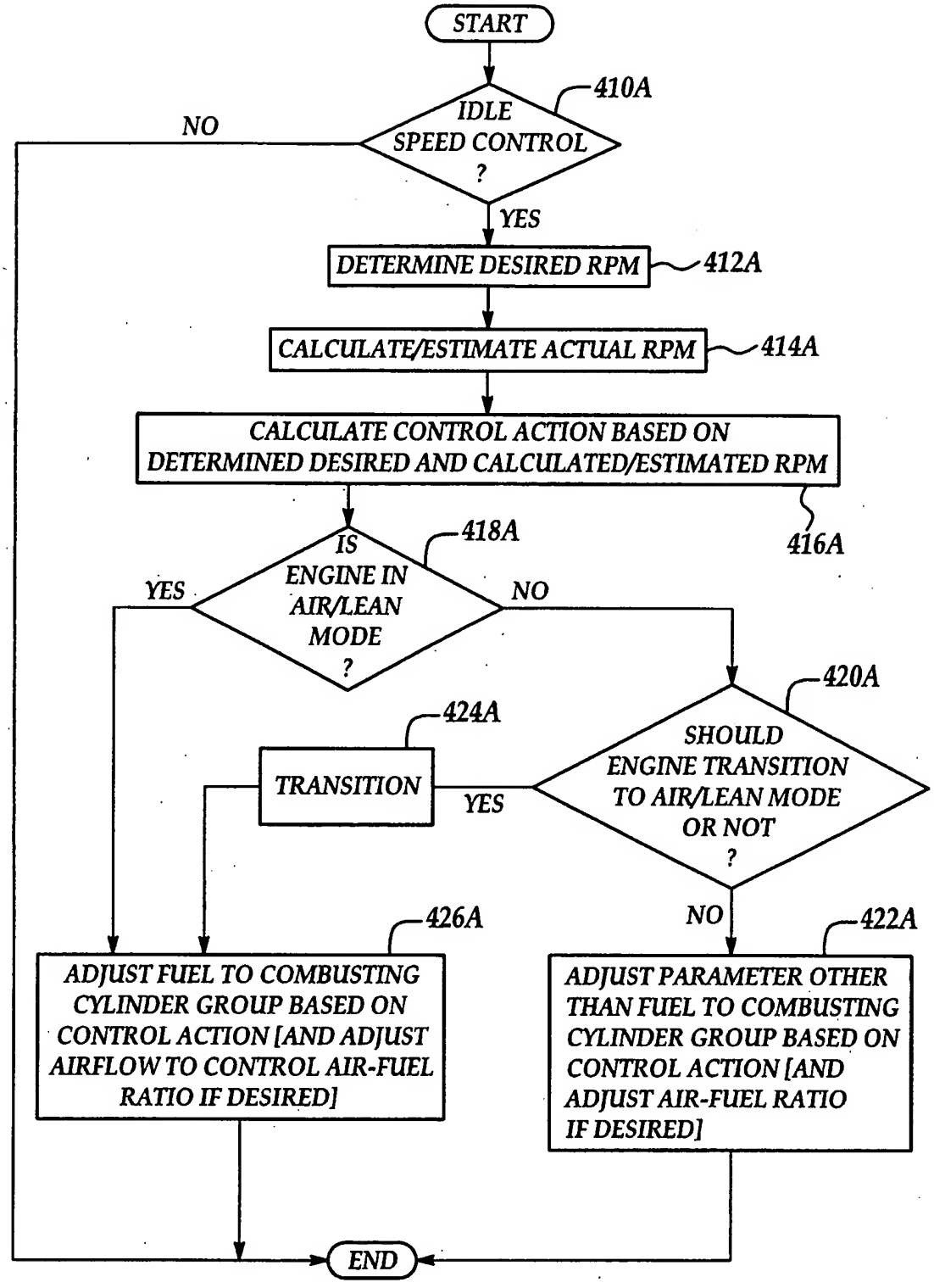

START
410A
IDLE SPEED CONTROL ?
NO
YES
DETERMINE DESIRED RPM
412A
CALCULATE/ESTIMATE ACTUAL RPM
414A
CALCULATE CONTROL ACTION BASED ON DETERMINED DESIRED AND CALCULATED/ESTIMATED RPM
416A
418A
IS ENGINE IN AIR/LEAN MODE ?
YES
NO
420A
SHOULD ENGINE TRANSITION TO AIR/LEAN MODE OR NOT ?
424A
TRANSITION
YES
NO
426A
ADJUST FUEL TO COMBUSTING CYLINDER GROUP BASED ON CONTROL ACTION [AND ADJUST AIRFLOW TO CONTROL AIR-FUEL RATIO IF DESIRED]
422A
ADJUST PARAMETER OTHER THAN FUEL TO COMBUSTING CYLINDER GROUP BASED ON CONTROL ACTION [AND ADJUST AIR-FUEL RATIO IF DESIRED]
END

Figure 4A

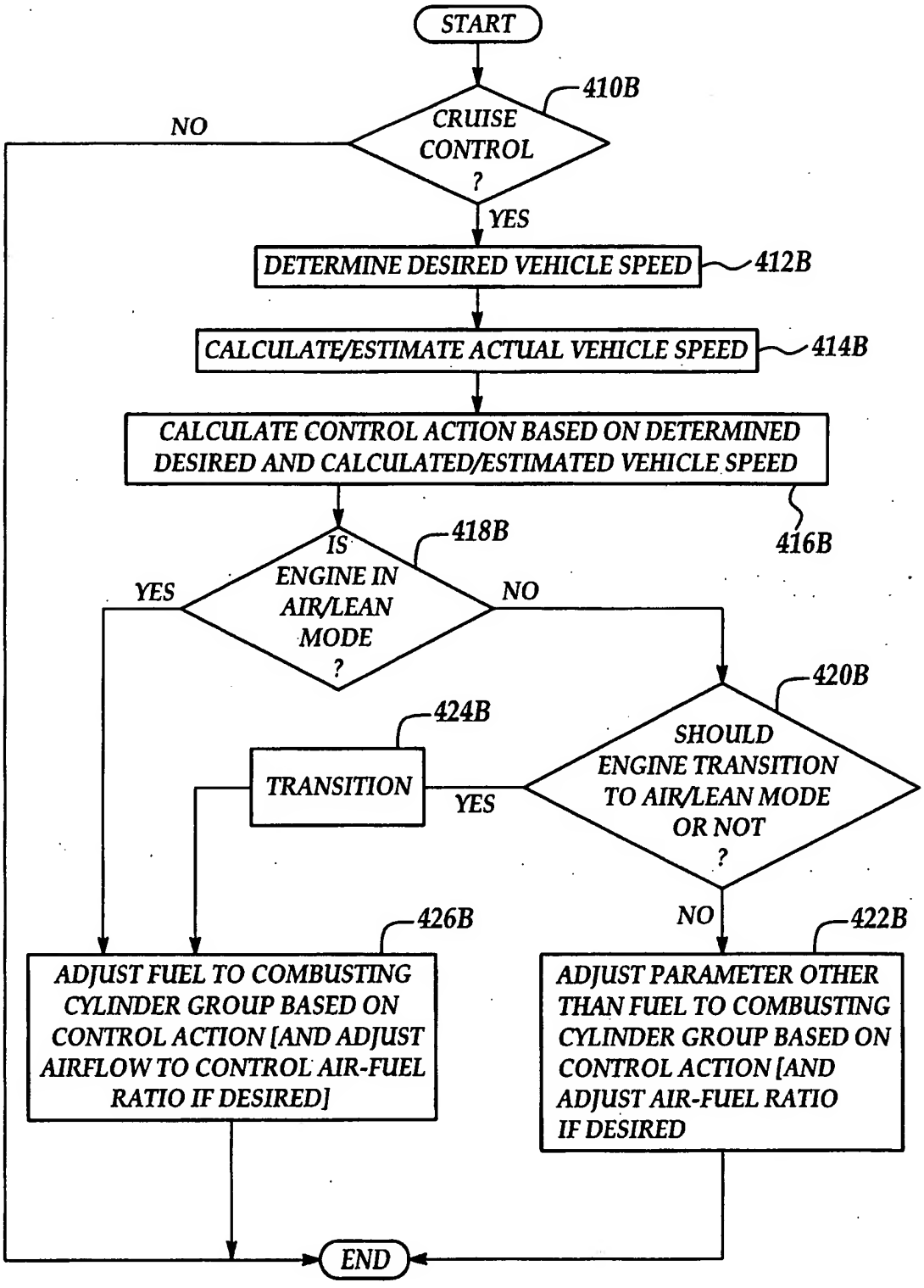

START
410B
CRUISE CONTROL ?
NO
YES
DETERMINE DESIRED VEHICLE SPEED
412B
CALCULATE/ESTIMATE ACTUAL VEHICLE SPEED
414B
CALCULATE CONTROL ACTION BASED ON DETERMINED DESIRED AND CALCULATED/ESTIMATED VEHICLE SPEED
416B
418B
IS ENGINE IN AIR/LEAN MODE ?
YES
NO
420B
SHOULD ENGINE TRANSITION TO AIR/LEAN MODE OR NOT ?
424B
TRANSITION
YES
NO
426B
ADJUST FUEL TO COMBUSTING CYLINDER GROUP BASED ON CONTROL ACTION [AND ADJUST AIRFLOW TO CONTROL AIR-FUEL RATIO IF DESIRED]
422B
ADJUST PARAMETER OTHER THAN FUEL TO COMBUSTING CYLINDER GROUP BASED ON CONTROL ACTION [AND ADJUST AIR-FUEL RATIO IF DESIRED
END

Figure 4B

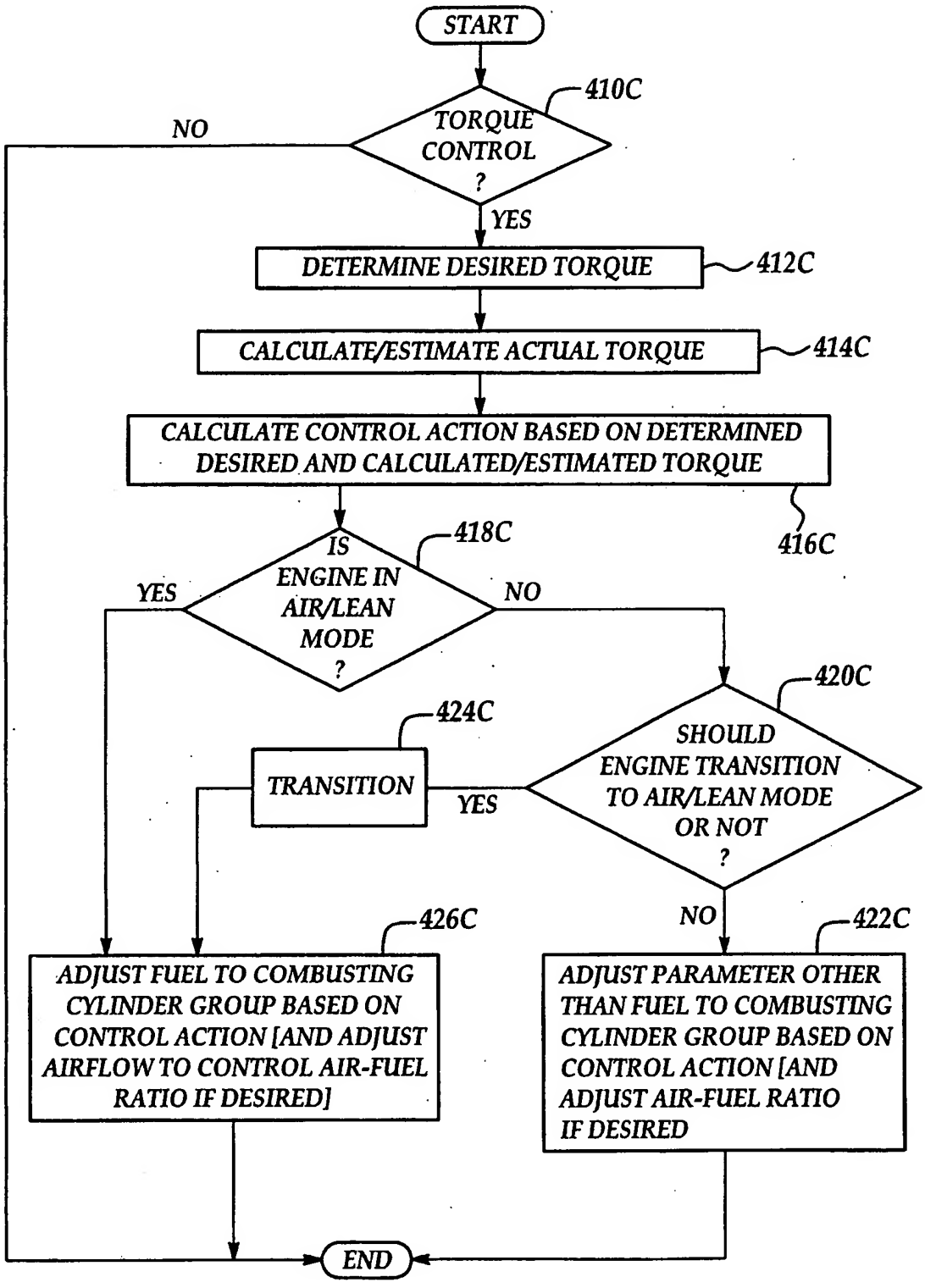

START
410C
TORQUE CONTROL ?
NO
YES
DETERMINE DESIRED TORQUE
412C
CALCULATE/ESTIMATE ACTUAL TORQUE
414C
CALCULATE CONTROL ACTION BASED ON DETERMINED DESIRED AND CALCULATED/ESTIMATED TORQUE
416C
418C
IS ENGINE IN AIR/LEAN MODE ?
YES
NO
420C
SHOULD ENGINE TRANSITION TO AIR/LEAN MODE OR NOT ?
424C
TRANSITION
YES
NO
426C
ADJUST FUEL TO COMBUSTING CYLINDER GROUP BASED ON CONTROL ACTION [AND ADJUST AIRFLOW TO CONTROL AIR-FUEL RATIO IF DESIRED]
422C
ADJUST PARAMETER OTHER THAN FUEL TO COMBUSTING CYLINDER GROUP BASED ON CONTROL ACTION [AND ADJUST AIR-FUEL RATIO IF DESIRED
END

Figure 4C

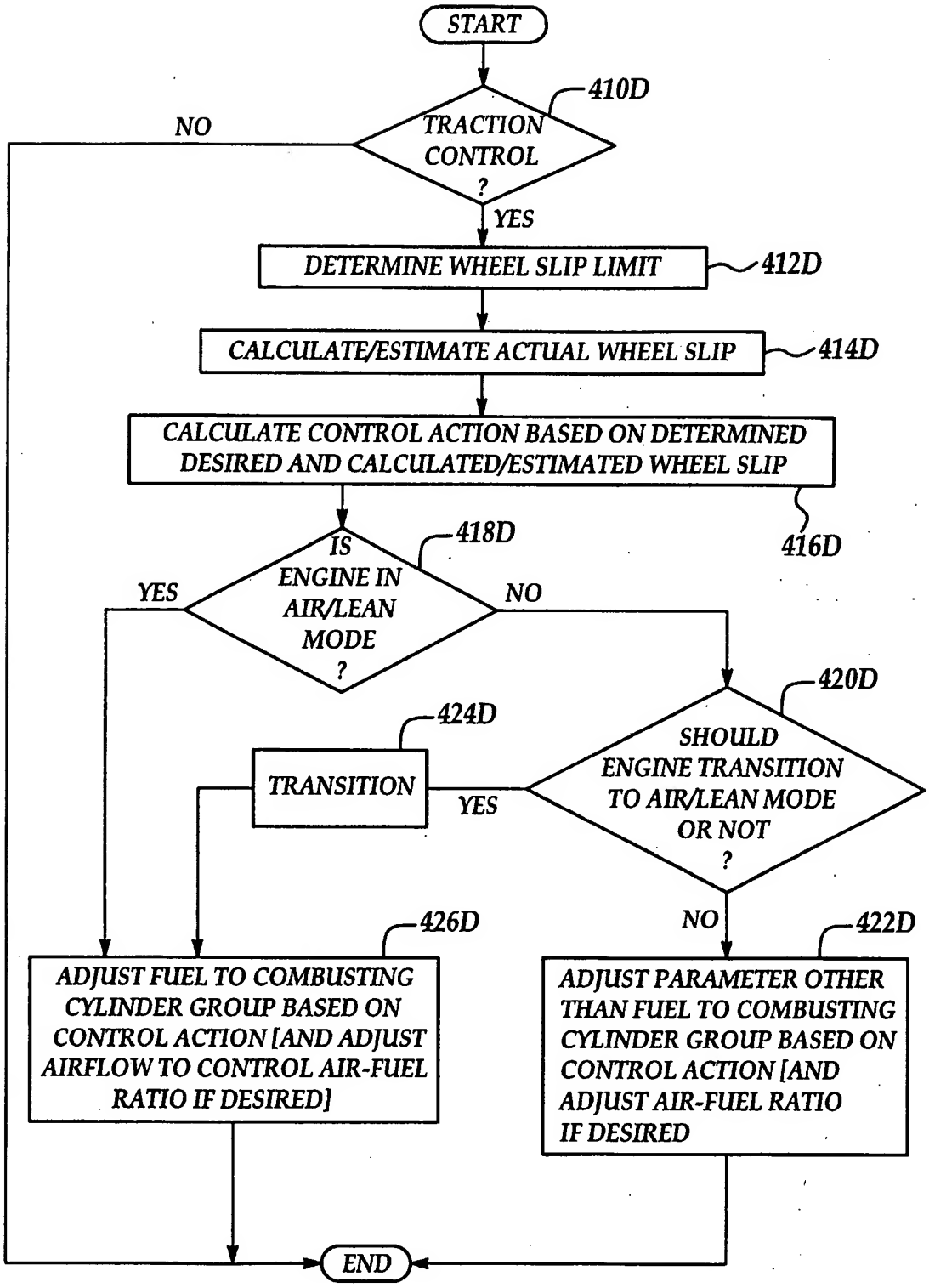

START
410D
TRACTION CONTROL ?
NO
YES
DETERMINE WHEEL SLIP LIMIT
412D
CALCULATE/ESTIMATE ACTUAL WHEEL SLIP
414D
CALCULATE CONTROL ACTION BASED ON DETERMINED DESIRED AND CALCULATED/ESTIMATED WHEEL SLIP
416D
418D
IS ENGINE IN AIR/LEAN MODE ?
YES
NO
420D
SHOULD ENGINE TRANSITION TO AIR/LEAN MODE OR NOT ?
424D
TRANSITION
YES
NO
426D
ADJUST FUEL TO COMBUSTING CYLINDER GROUP BASED ON CONTROL ACTION [AND ADJUST AIRFLOW TO CONTROL AIR-FUEL RATIO IF DESIRED]
422D
ADJUST PARAMETER OTHER THAN FUEL TO COMBUSTING CYLINDER GROUP BASED ON CONTROL ACTION [AND ADJUST AIR-FUEL RATIO IF DESIRED
END

Figure 4D

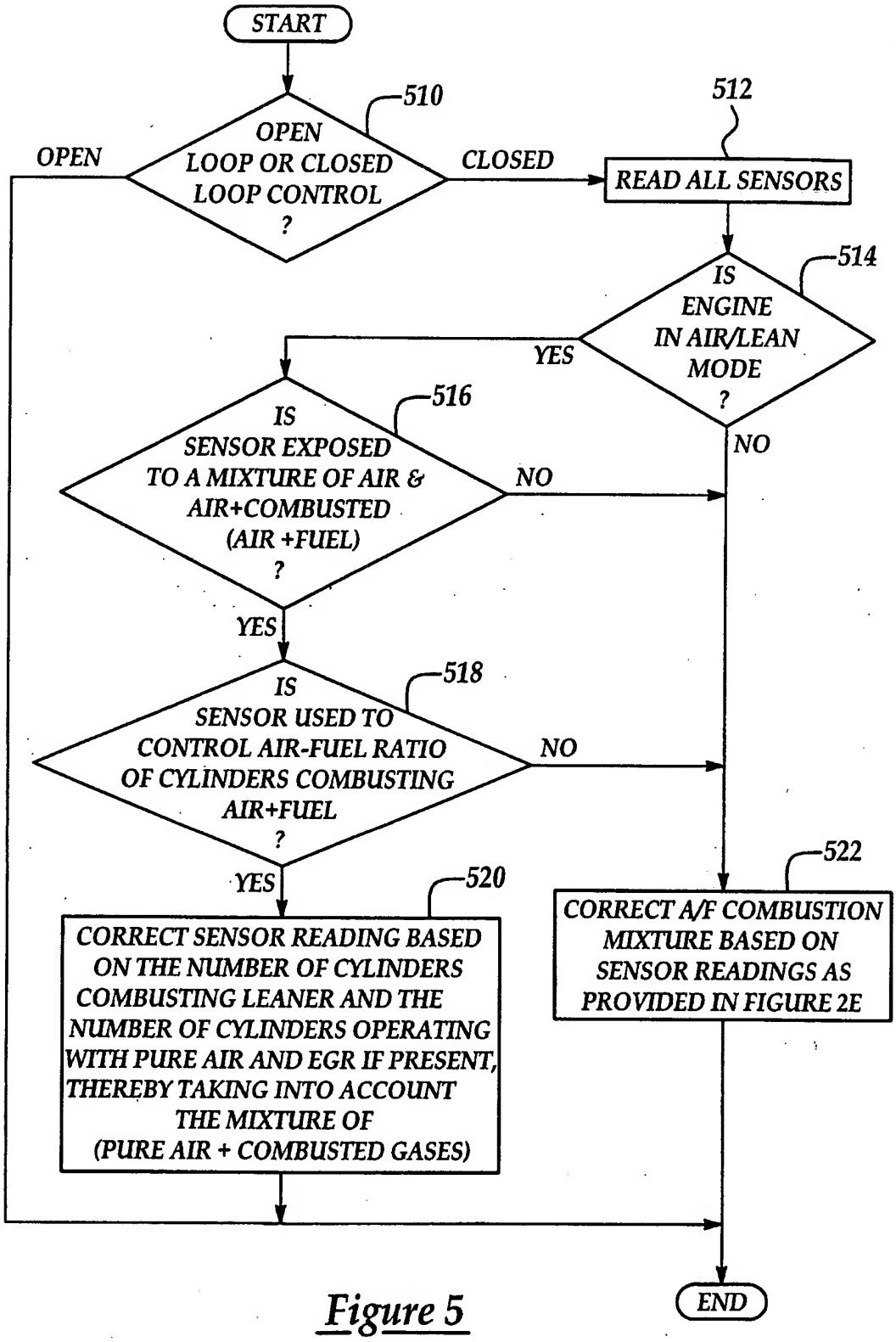

START
510
OPEN LOOP OR CLOSED LOOP CONTROL ?
OPEN
CLOSED
512
READ ALL SENSORS
514
IS ENGINE IN AIR/LEAN MODE ?
YES
NO
516
IS SENSOR EXPOSED TO A MIXTURE OF AIR & AIR+COMBUSTED (AIR +FUEL) ?
NO
YES
518
IS SENSOR USED TO CONTROL AIR-FUEL RATIO OF CYLINDERS COMBUSTING AIR+FUEL ?
NO
YES
520
CORRECT SENSOR READING BASED ON THE NUMBER OF CYLINDERS COMBUSTING LEANER AND THE NUMBER OF CYLINDERS OPERATING WITH PURE AIR AND EGR IF PRESENT, THEREBY TAKING INTO ACCOUNT THE MIXTURE OF (PURE AIR + COMBUSTED GASES)
522
CORRECT A/F COMBUSTION MIXTURE BASED ON SENSOR READINGS AS PROVIDED IN FIGURE 2E
END

Figure 5

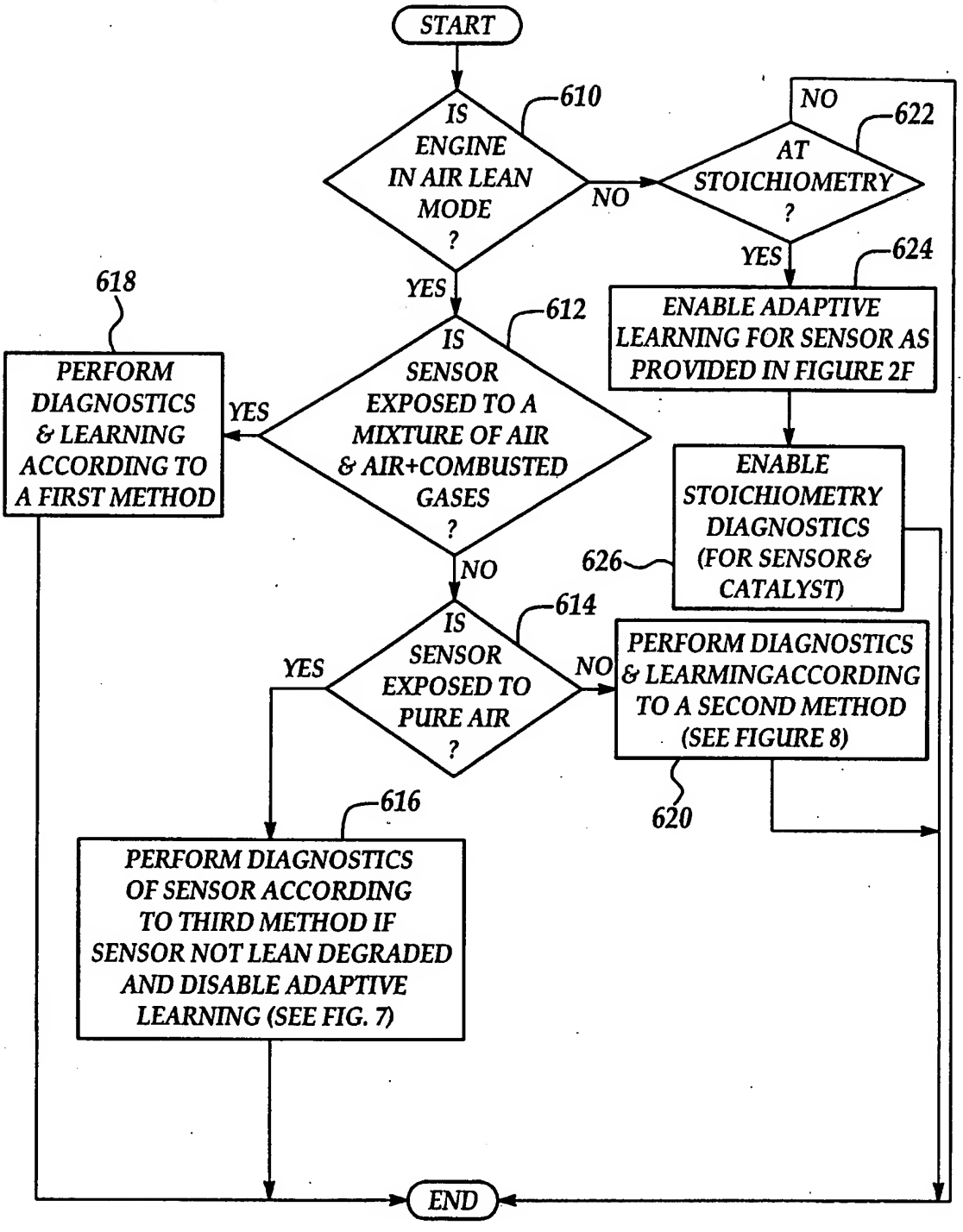

START
IS ENGINE IN AIR LEAN MODE ?
610
NO
AT STOICHIOMETRY ?
622
YES
624
ENABLE ADAPTIVE LEARNING FOR SENSOR AS PROVIDED IN FIGURE 2F
ENABLE STOICHIOMETRY DIAGNOSTICS (FOR SENSOR& CATALYST)
626
YES
618
PERFORM DIAGNOSTICS & LEARNING ACCORDING TO A FIRST METHOD
IS SENSOR EXPOSED TO A MIXTURE OF AIR & AIR+COMBUSTED GASES ?
612
NO
IS SENSOR EXPOSED TO PURE AIR ?
614
YES
NO
PERFORM DIAGNOSTICS & LEARMINGACCORDING TO A SECOND METHOD (SEE FIGURE 8)
620
616
PERFORM DIAGNOSTICS OF SENSOR ACCORDING TO THIRD METHOD IF SENSOR NOT LEAN DEGRADED AND DISABLE ADAPTIVE LEARNING (SEE FIG. 7)
END

Figure 6

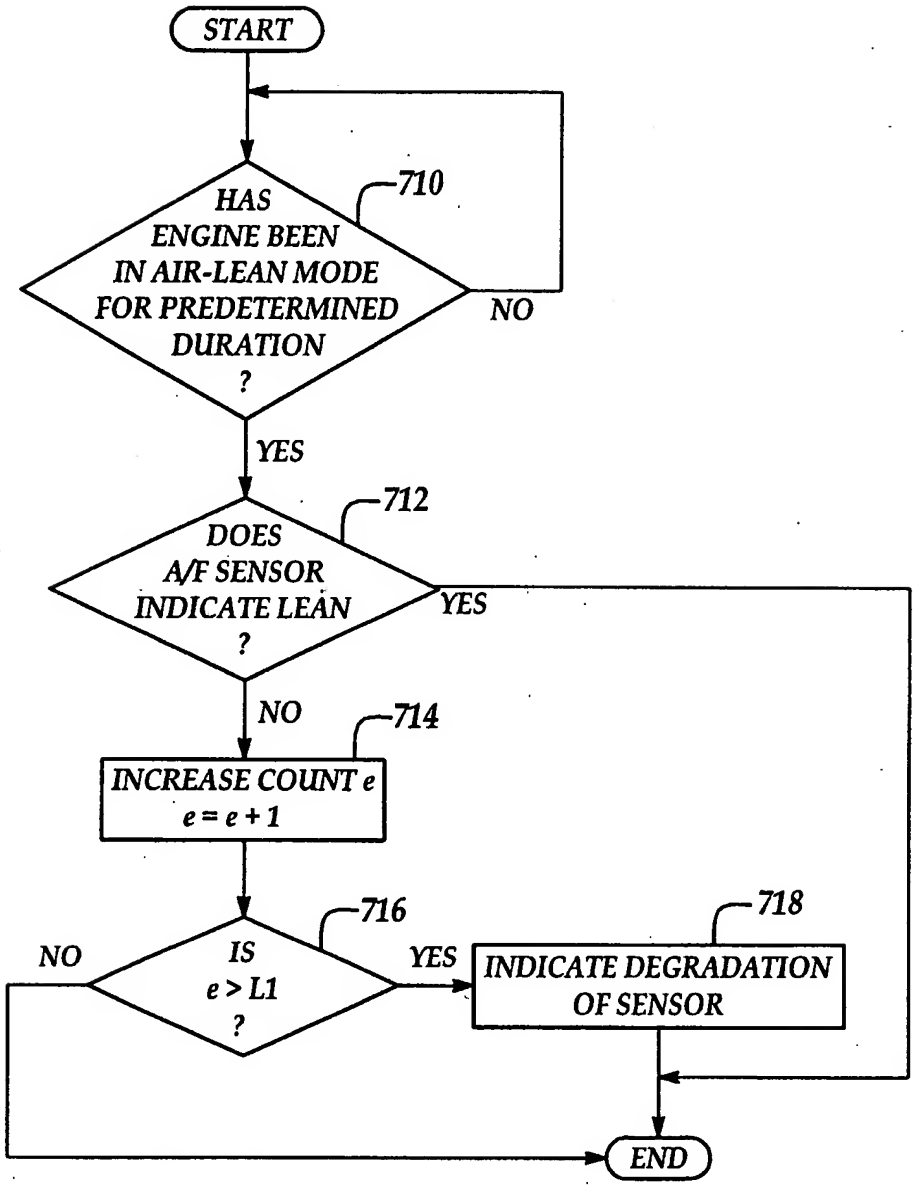

START
HAS ENGINE BEEN IN AIR-LEAN MODE FOR PREDETERMINED DURATION ?
710
NO
YES
DOES A/F SENSOR INDICATE LEAN ?
712
YES
NO
INCREASE COUNT e
e = e + 1
714
IS e > L1 ?
716
NO
YES
INDICATE DEGRADATION OF SENSOR
718
END

Figure 7

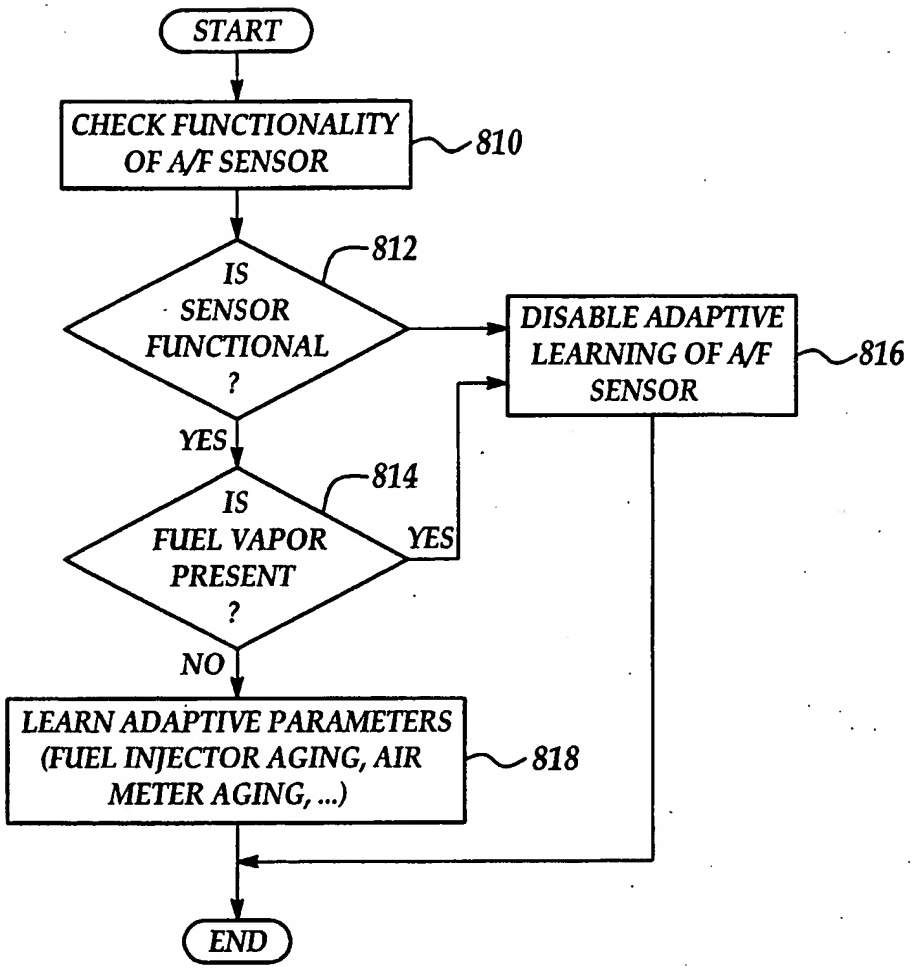


Figure 8

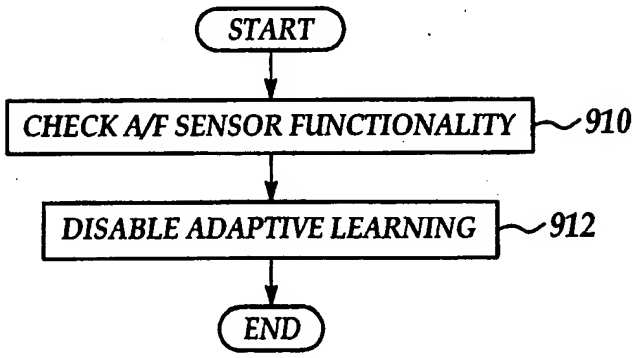


Figure 9

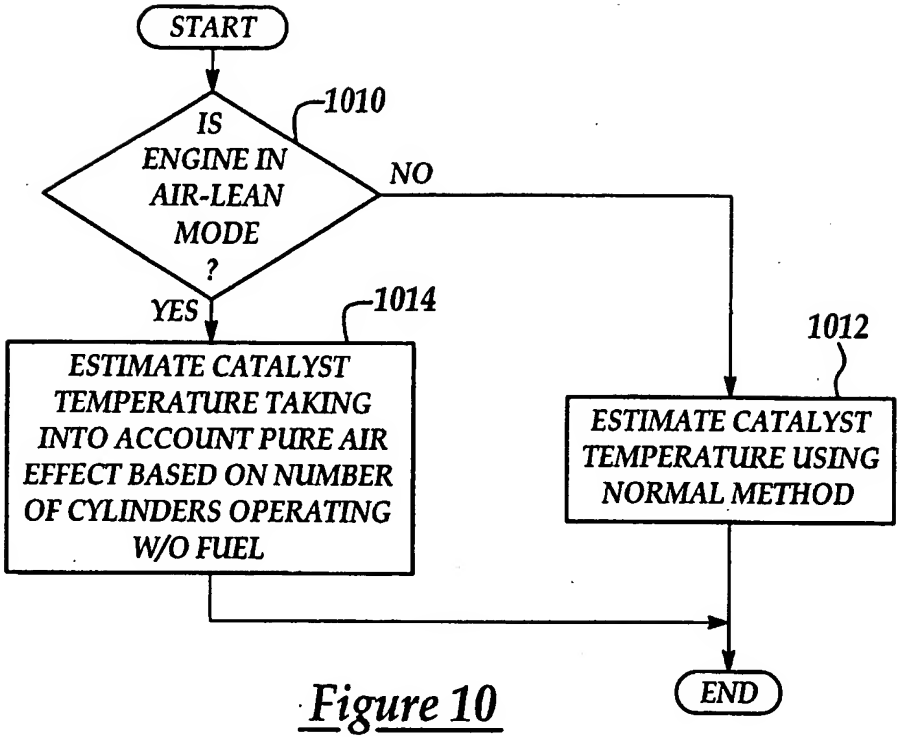


Figure 10

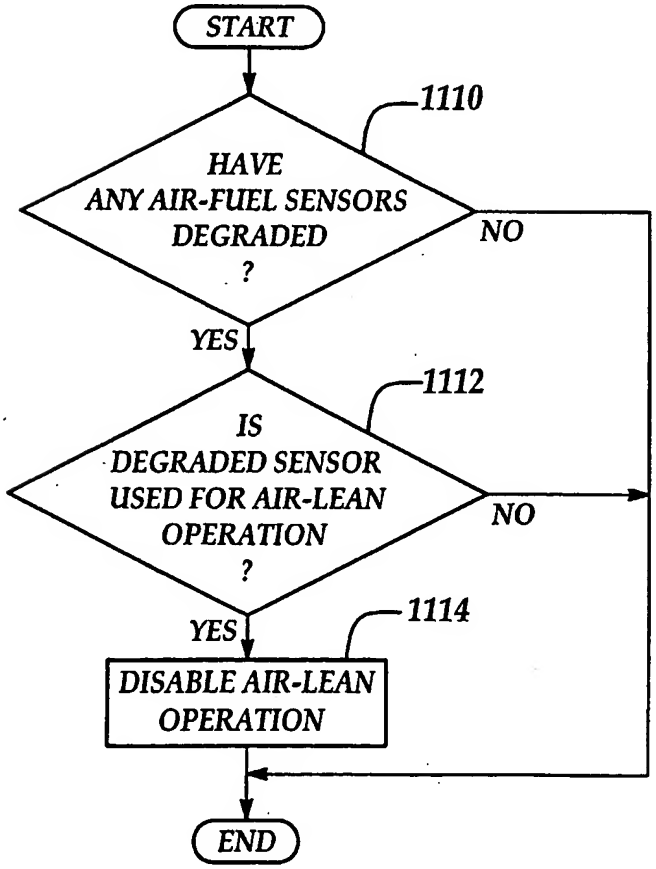


Figure 11

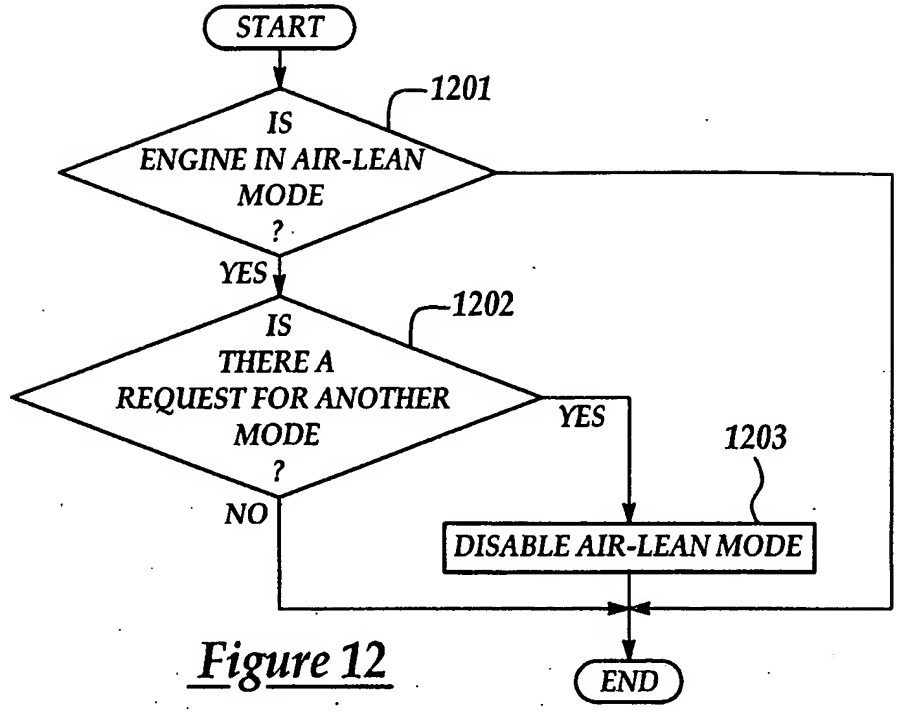


Figure 12

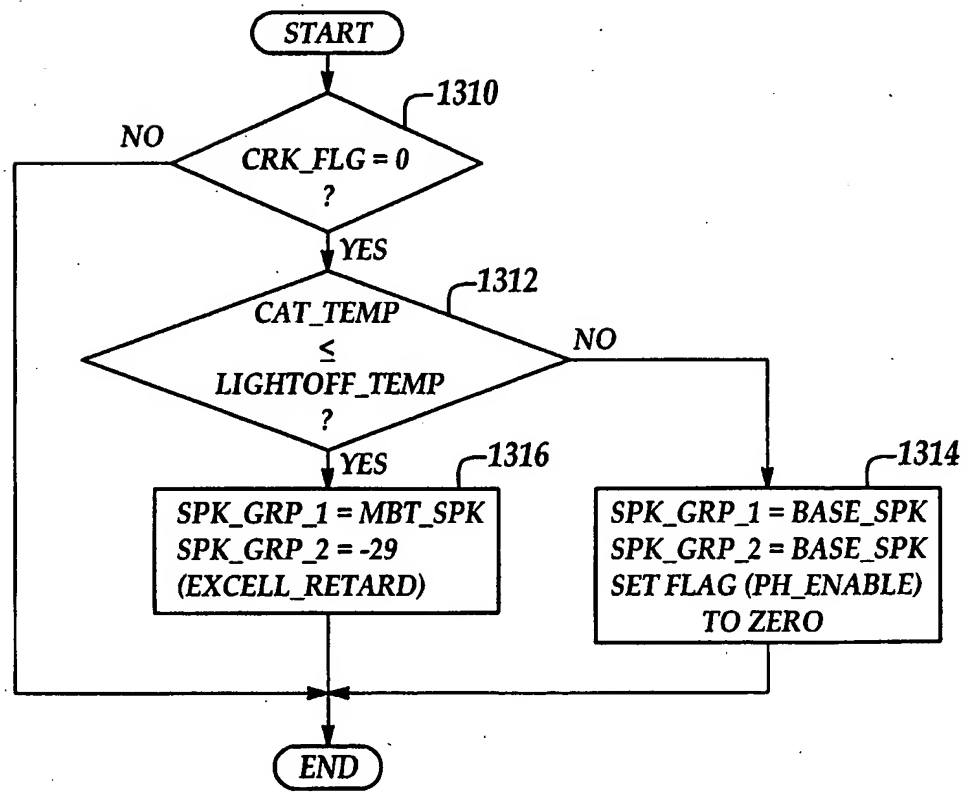


Figure 13A

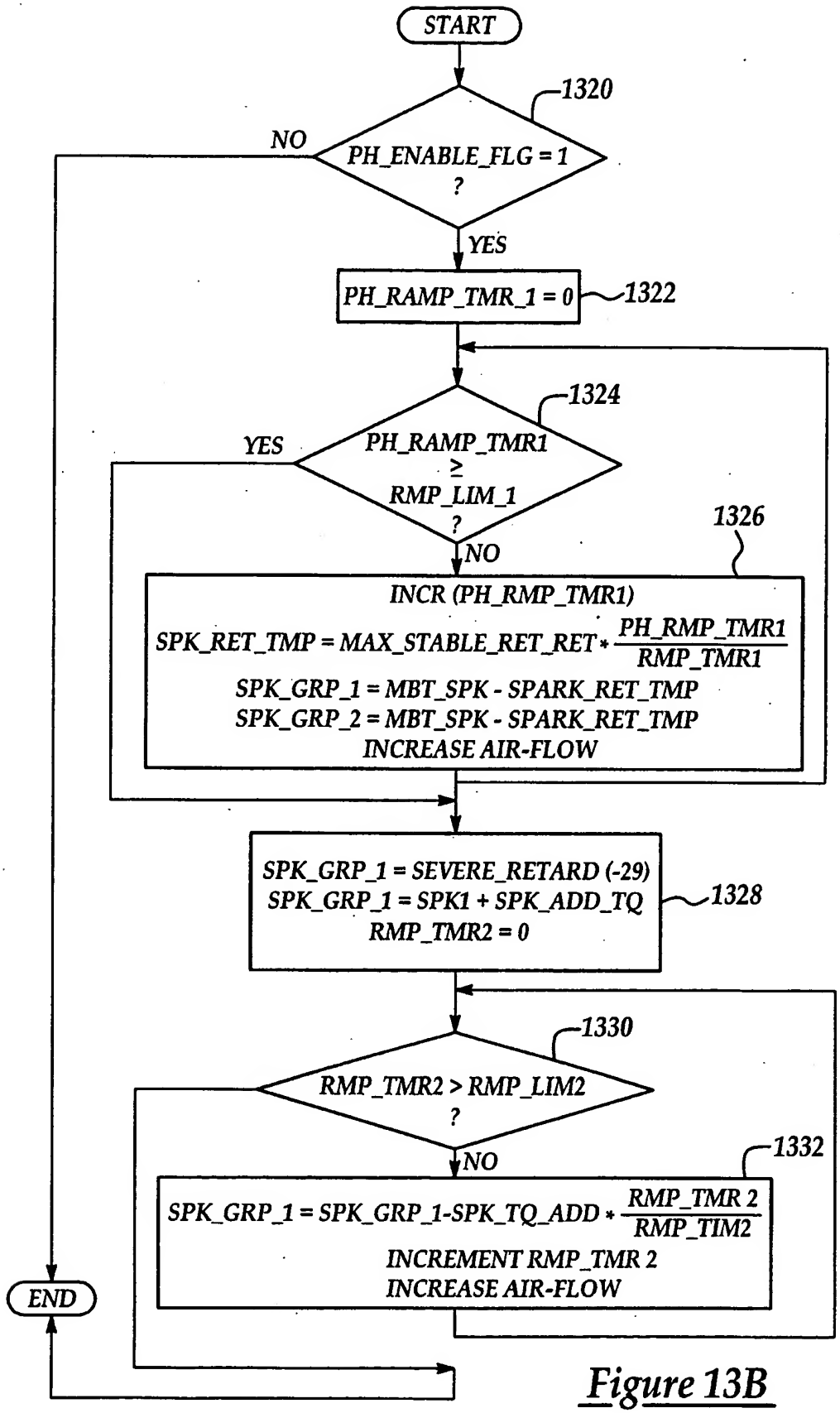

START
1320
NO
PH_ENABLE_FLG = 1
?
YES
PH_RAMP_TMR_1 = 0
1322
1324
YES
PH_RAMP_TMR1
≥
RMP_LIM_1
?
NO
1326
INCR (PH_RMP_TMR1)
SPK_RET_TMP = MAX_STABLE_RET_RET * PH_RMP_TMR1 / RMP_TMR1
SPK_GRP_1 = MBT_SPK - SPARK_RET_TMP
SPK_GRP_2 = MBT_SPK - SPARK_RET_TMP
INCREASE AIR-FLOW
SPK_GRP_1 = SEVERE_RETARD (-29)
SPK_GRP_1 = SPK1 + SPK_ADD_TQ
RMP_TMR2 = 0
1328
1330
RMP_TMR2 > RMP_LIM2
?
NO
1332
SPK_GRP_1 = SPK_GRP_1-SPK_TQ_ADD * RMP_TMR 2 / RMP_TIM2
INCREMENT RMP_TMR 2
INCREASE AIR-FLOW
END

Figure 13B

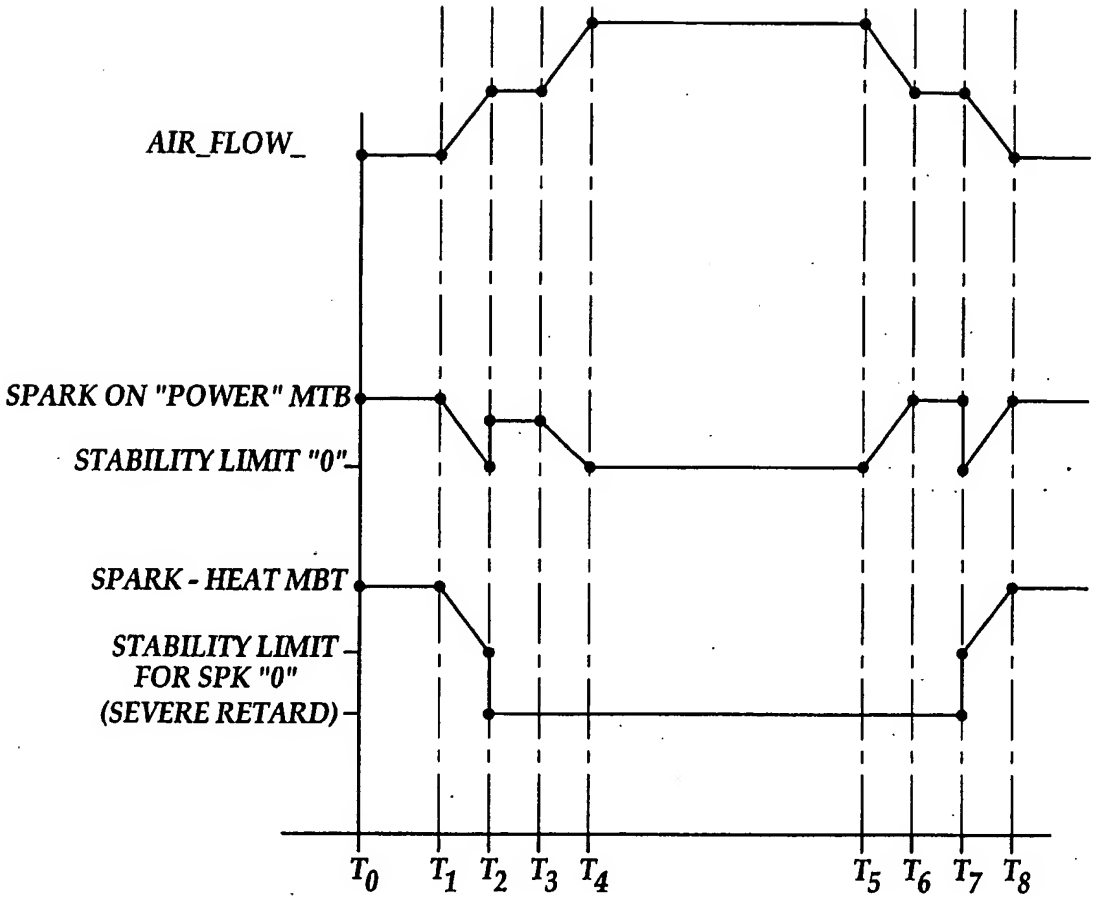

AIR_FLOW_
SPARK ON "POWER" MTB
STABILITY LIMIT "0"
SPARK - HEAT MBT
STABILITY LIMIT FOR SPK "0" (SEVERE RETARD)
T0
T1
T2
T3
T4
T5
T6
T7
T8

Figure 13C

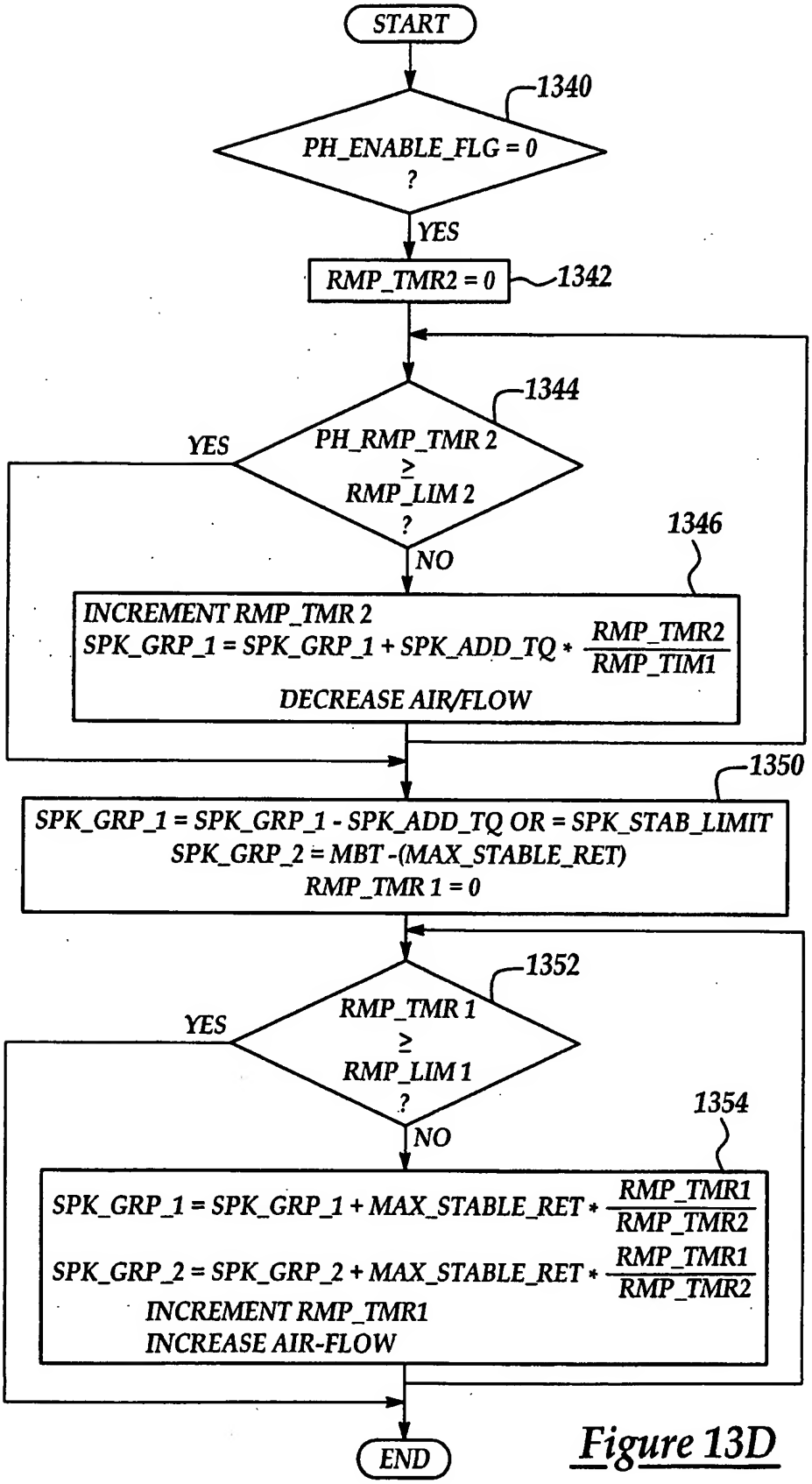

START
1340
PH_ENABLE_FLG = 0 ?
YES
RMP_TMR2 = 0
1342
1344
PH_RMP_TMR 2 ≥ RMP_LIM 2 ?
YES
NO
1346
INCREMENT RMP_TMR 2
SPK_GRP_1 = SPK_GRP_1 + SPK_ADD_TQ * RMP_TMR2 / RMP_TIM1
DECREASE AIR/FLOW
1350
SPK_GRP_1 = SPK_GRP_1 - SPK_ADD_TQ OR = SPK_STAB_LIMIT
SPK_GRP_2 = MBT -(MAX_STABLE_RET)
RMP_TMR 1 = 0
1352
RMP_TMR 1 ≥ RMP_LIM 1 ?
YES
NO
1354
SPK_GRP_1 = SPK_GRP_1 + MAX_STABLE_RET * RMP_TMR1 / RMP_TMR2
SPK_GRP_2 = SPK_GRP_2 + MAX_STABLE_RET * RMP_TMR1 / RMP_TMR2
INCREMENT RMP_TMR1
INCREASE AIR-FLOW
END

Figure 13D

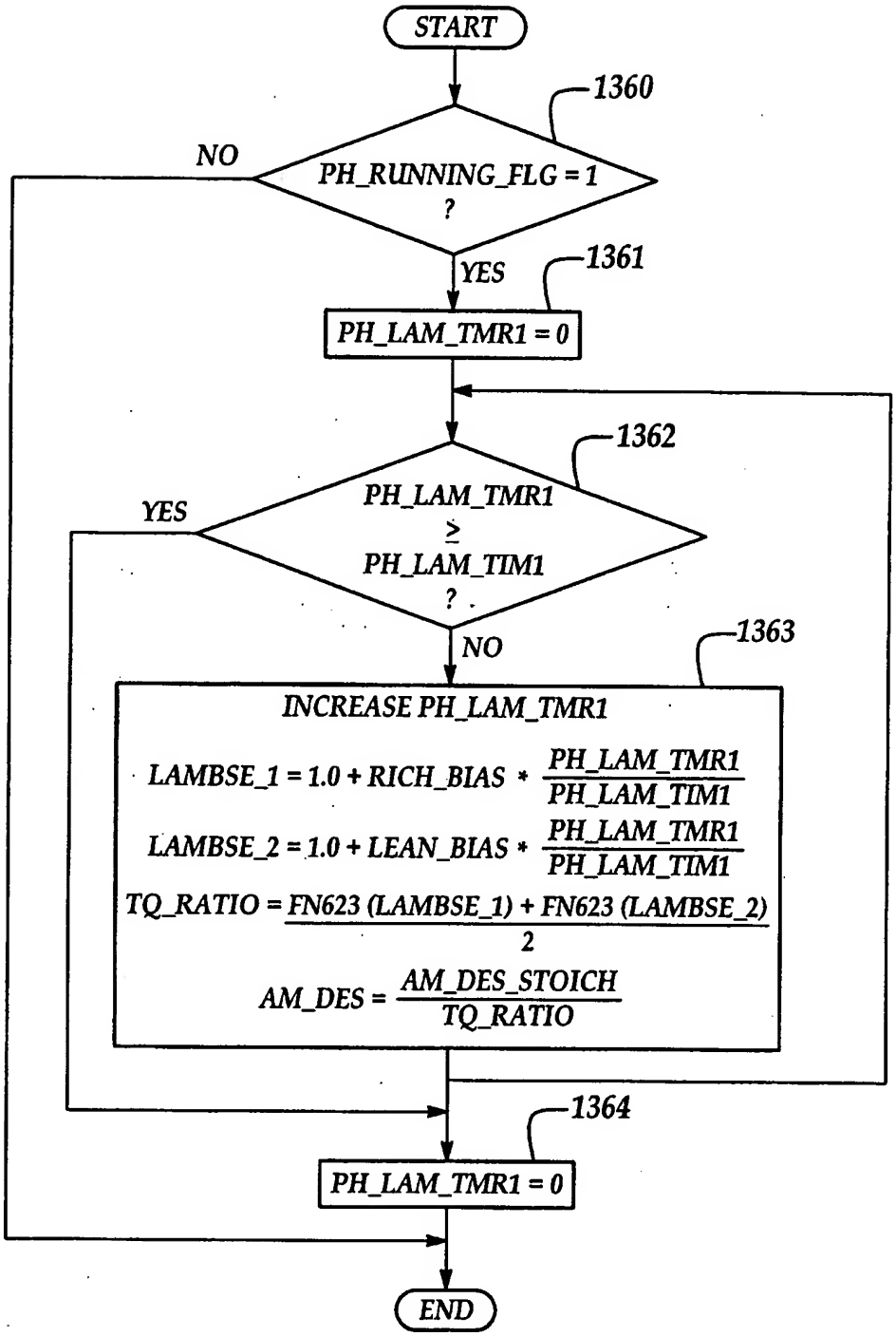

START
1360
NO
PH_RUNNING_FLG = 1
?
YES
1361
PH_LAM_TMR1 = 0
1362
YES
PH_LAM_TMR1
≥
PH_LAM_TIM1
?
NO
1363
INCREASE PH_LAM_TMR1
LAMBSE_1 = 1.0 + RICH_BIAS * PH_LAM_TMR1 / PH_LAM_TIM1
LAMBSE_2 = 1.0 + LEAN_BIAS * PH_LAM_TMR1 / PH_LAM_TIM1
TQ_RATIO = FN623 (LAMBSE_1) + FN623 (LAMBSE_2) / 2
AM_DES = AM_DES_STOICH / TQ_RATIO
1364
PH_LAM_TMR1 = 0
END

Figure 13E

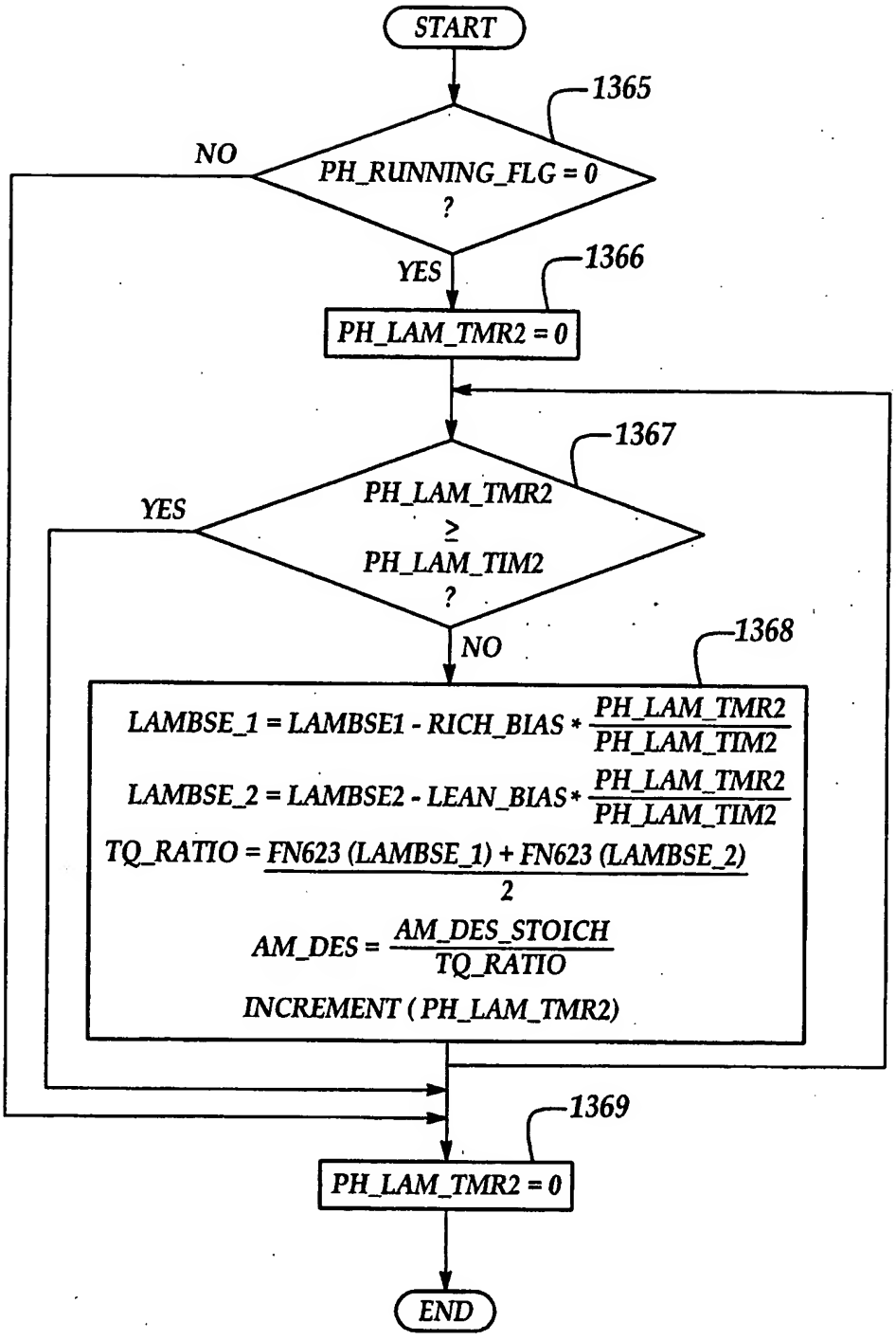

START
1365
NO
PH_RUNNING_FLG = 0
?
YES
1366
PH_LAM_TMR2 = 0
1367
YES
PH_LAM_TMR2
≥
PH_LAM_TIM2
?
NO
1368
LAMBSE_1 = LAMBSE1 - RICH_BIAS * PH_LAM_TMR2 / PH_LAM_TIM2
LAMBSE_2 = LAMBSE2 - LEAN_BIAS * PH_LAM_TMR2 / PH_LAM_TIM2
TQ_RATIO = FN623 (LAMBSE_1) + FN623 (LAMBSE_2) / 2
AM_DES = AM_DES_STOICH / TQ_RATIO
INCREMENT (PH_LAM_TMR2)
1369
PH_LAM_TMR2 = 0
END

Figure 13F

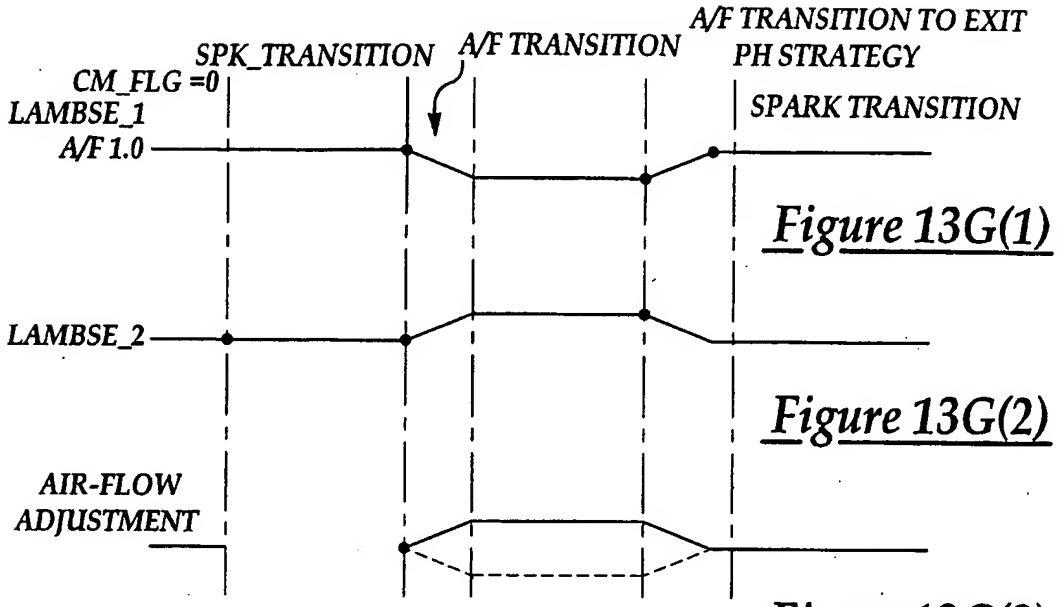


Figure 13G(1)

Figure 13G(2)

Figure 13G(3)

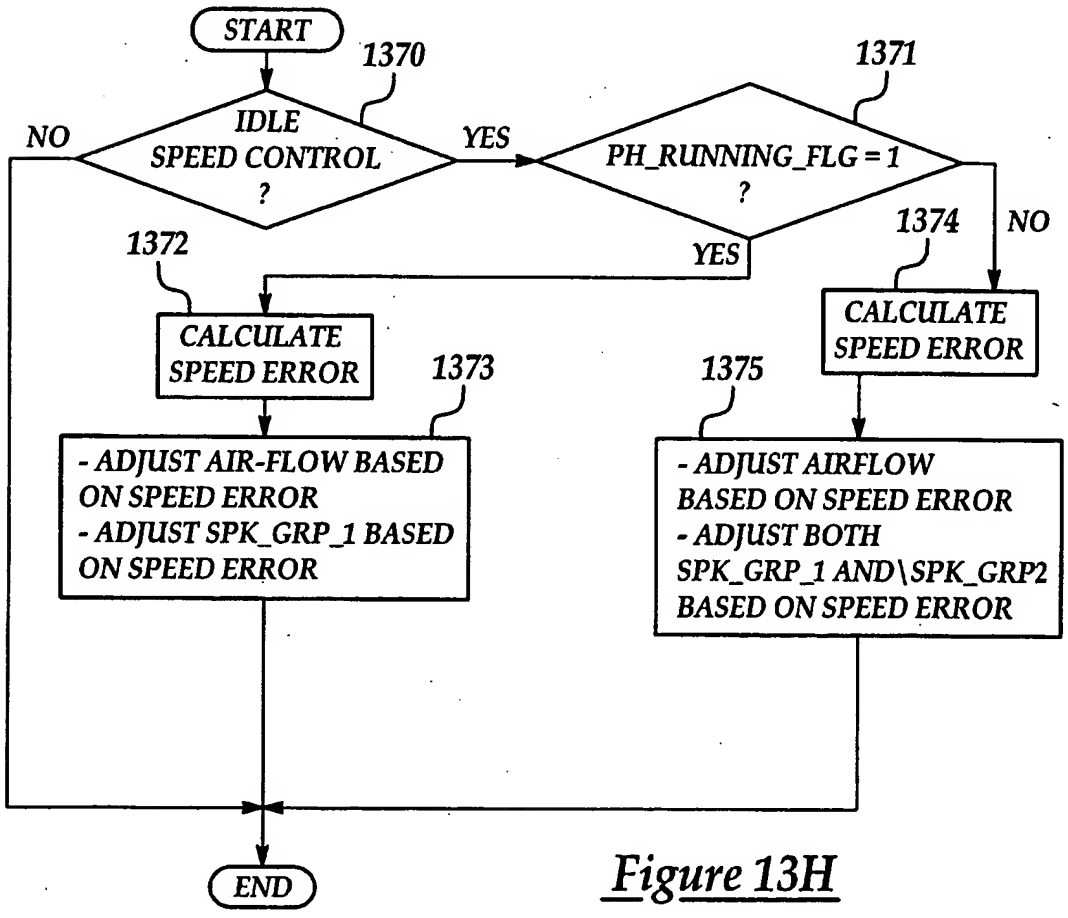


Figure 13H

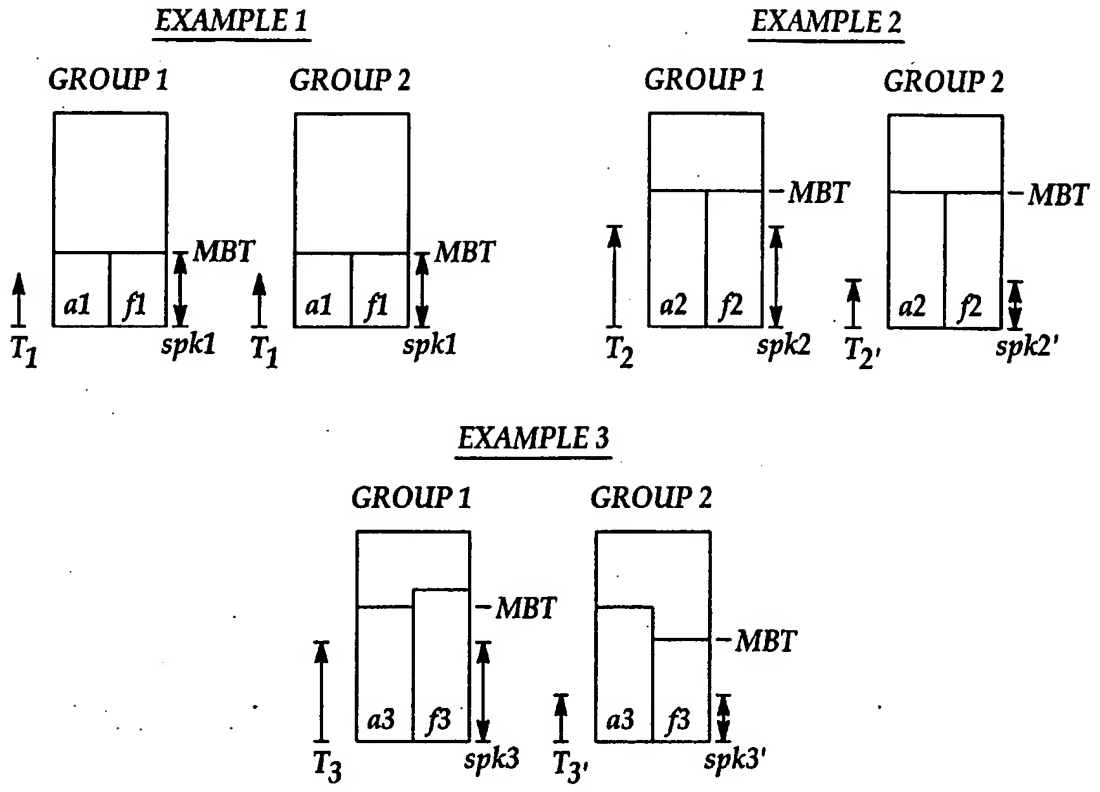


Figure 13I

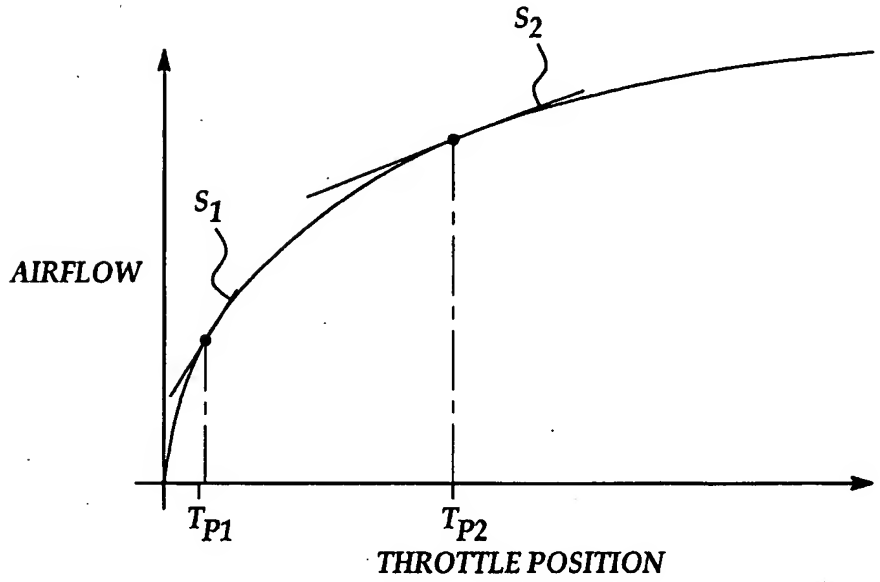


Figure 13J

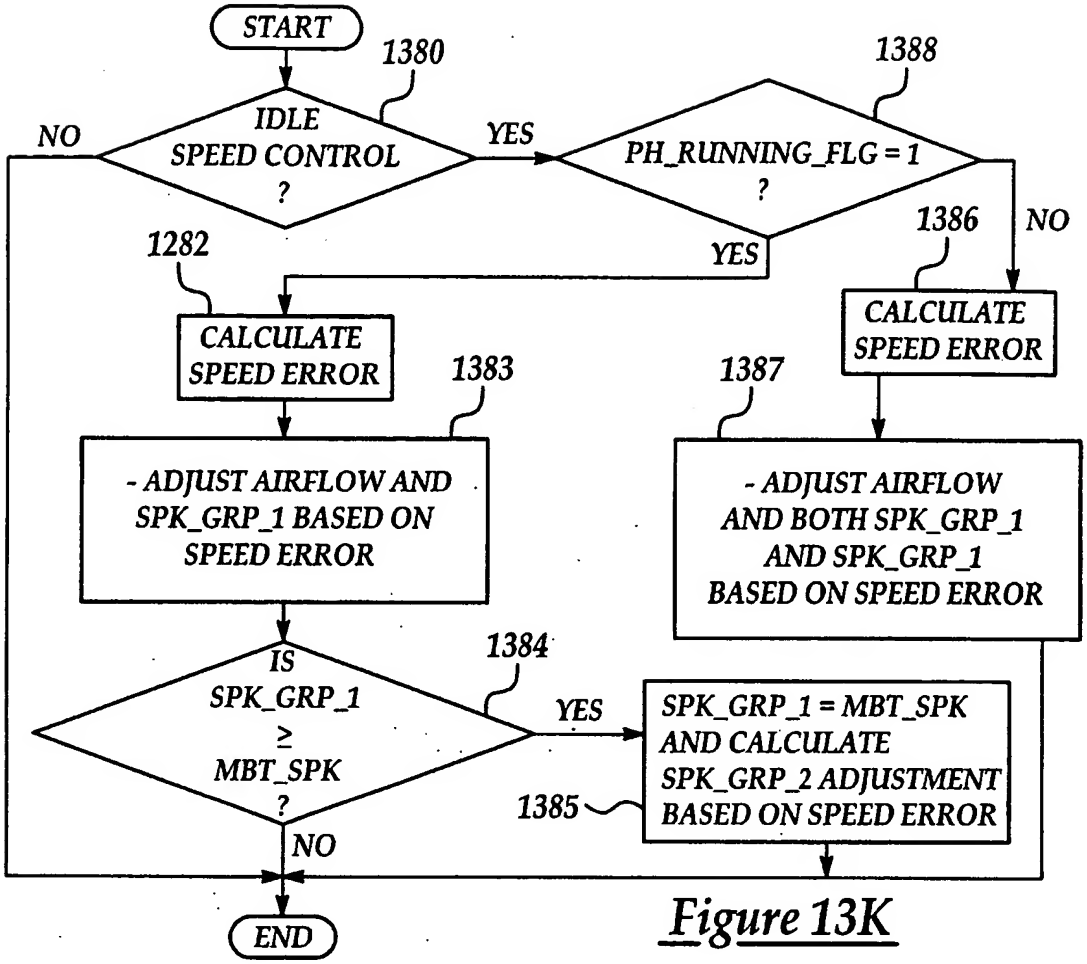


Figure 13K

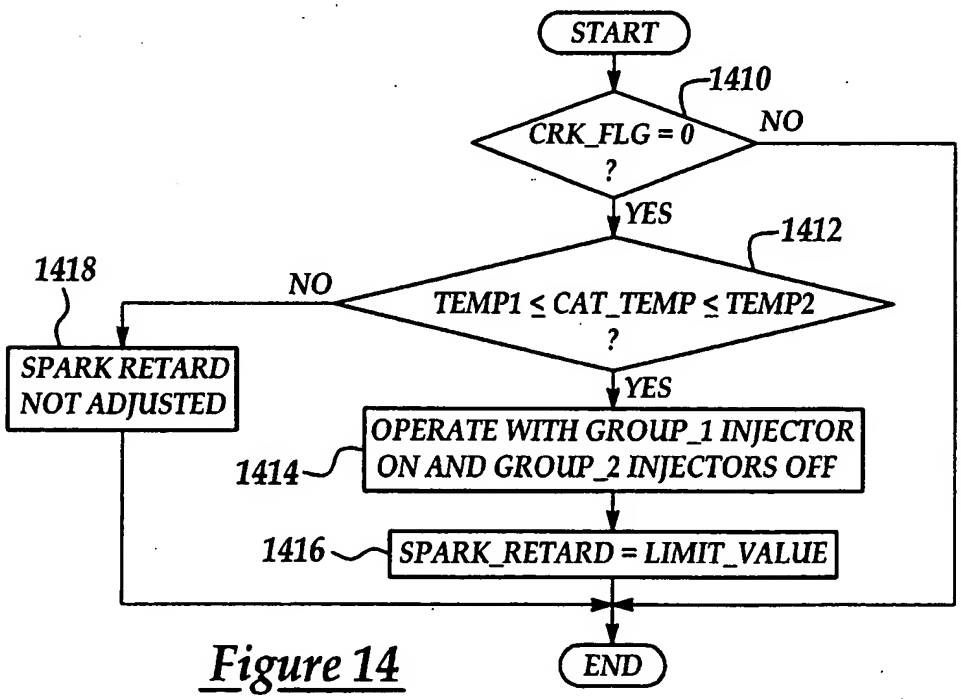


Figure 14

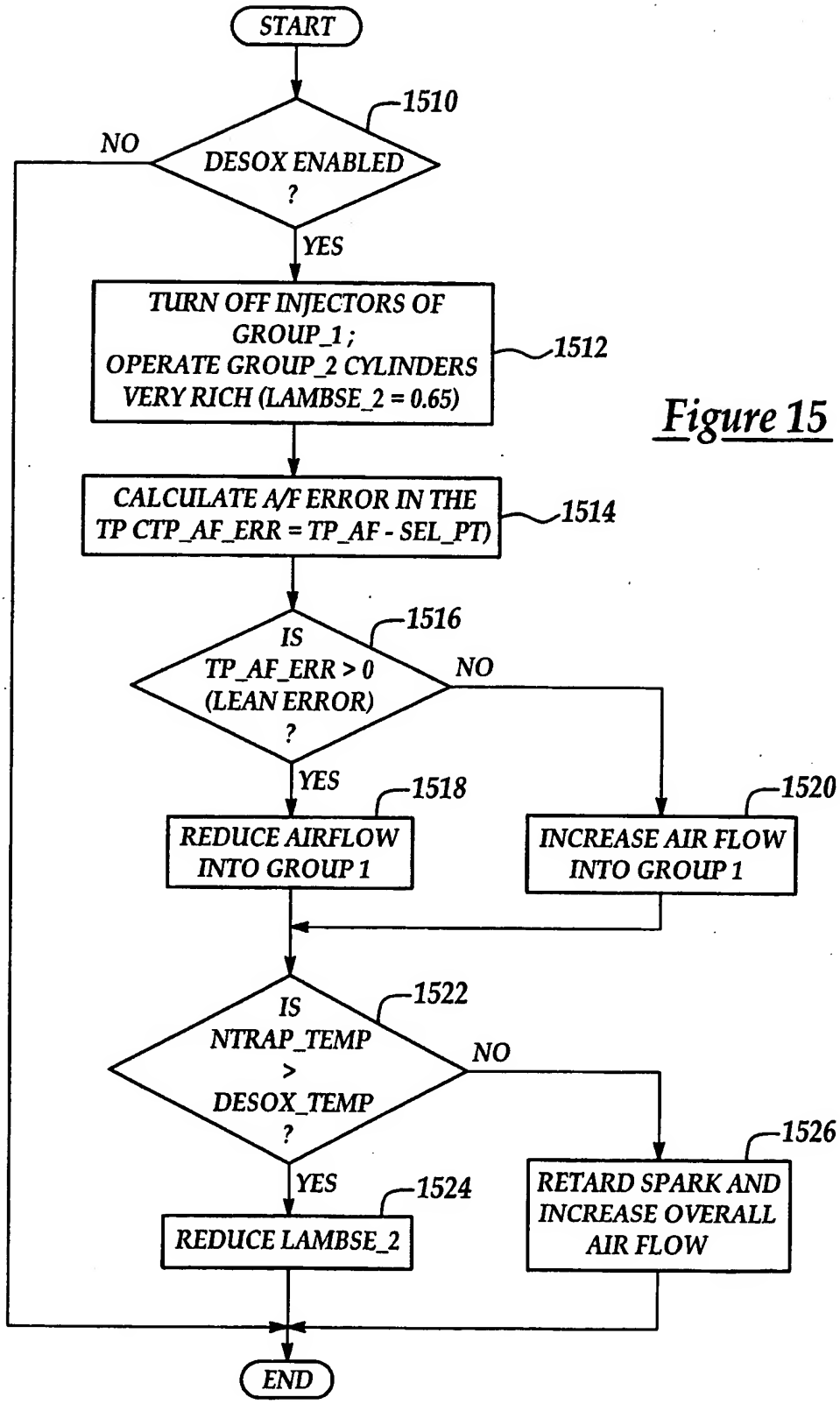

START
1510
DESOX ENABLED ?
NO
YES
TURN OFF INJECTORS OF GROUP_1 ; OPERATE GROUP_2 CYLINDERS VERY RICH (LAMBSE_2 = 0.65)
1512
CALCULATE A/F ERROR IN THE TP CTP_AF_ERR = TP_AF - SEL_PT)
1514
IS TP_AF_ERR > 0 (LEAN ERROR) ?
1516
NO
YES
REDUCE AIRFLOW INTO GROUP 1
1518
INCREASE AIR FLOW INTO GROUP 1
1520
IS NTRAP_TEMP > DESOX_TEMP ?
1522
NO
YES
REDUCE LAMBSE_2
1524
RETARD SPARK AND INCREASE OVERALL AIR FLOW
1526
END

Figure 15